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PROCEEDINGS

OF THE

American Gas Institute

TENTH ANNUAL MEETING

SEPTEMBER 28, 1915

SAN FRANCISCO, CAL.

PUBLISHED BY THE INSTITUTE
EDITED BY THE PUBLICATION COMMITTEE
1916

PRESS OF
THE CHEMICAL PUBLISHING COMPANY
EASTON, PA

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1915-1916

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R. W. Bush	Brooklyn, N. Y.	1916
J. W. Dunbar	New Albany, Ind.	1916
James Ferrier	Rome, Ga.	1916
J. B. Klumpp	Philadelphia, Pa.	1916
C. H. Nettleton	Derby, Conn.	1916
D. D. Barnum	Worcester, Mass.	1917
R. B. Brown	Milwaukee, Wis.	1917
C. M. Cohn	Baltimore, Md.	1917
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R. B. Harper	Chicago, Ill.	1917
E. C. Jones	San Francisco, Cal.	*Ex-Officio*

Affiliation Representatives

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L. H. Johnson,	Illinois Gas Association	Sheboygan, Wis.
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S. E. De Frese,	Southern Gas Association	Chattanooga, Tenn.

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1914-1915

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A. E. Forstall	New York, N. Y.	1915
C. H. Graf	Albany, N. Y.	1915
Carroll Miller	Aurora, Ill.	1915
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James Ferrier	Rome, Ga.	1916
J. B. Klumpp	Philadelphia, Pa.	1916
C. H. Nettleton	Derby, Conn.	1916
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S. J. Glass,	Wisconsin Gas Association	Milwaukee, Wis.
W. F. Barrett,	Illinois Gas Association	Chicago, Ill.
L. R. Dutton,	Pennsylvania Gas Association	Wyncote, Pa.

PAST OFFICERS.

Presidents.

*B. W. Perkins	1906
Walton Clark	1906–1907
A. C. Humphreys	1907–1908
*C. F. Prichard	1908–1909
W. H. Bradley	1909–1910
Donald McDonald	1910–1911
I. C. Copley	1911–1912
W. R. Addicks	1912–1913
W. H. Gartley	1913–1914
E. C. Jones	1914–1915

Secretaries.

J. W. Dunbar	1906–1908
A. B. Beadle	1908–1911

PAST OFFICERS OF THE MERGED ASSOCIATIONS.

AMERICAN GAS LIGHT ASSOCIATION

1873-1906

Presidents

*Charles Roome	1873-79
*William H. Price	1880-81
*Andrew Hickenlooper	1882
*Theobald Forstall	1883
*William A. Stedman	1884
*Eugene Vanderpool	1885
*Austin C. Wood	1886
Malcolm S. Greenough	1887
*Thomas Turner	1888
*Alpheus B. Slater	1889
Emerson McMillin	1890
*John B. Harbison	1891
*William Henry White	1892
Arthur E. Boardman	1893
William H. Pearson	1894
Walton Clark	1895
C. J. R. Humphreys	1896
Chas. H. Nettleton	1897
*J. B. Crockett	1898
Alex. C. Humphreys	1899
Geo. G. Ramsdell	1900
Edward G. Pratt	1901
*Wm. R. Beal	1902
Alten S. Miller	1903
Rollin Norris	1904
E. G. Cowdery	1905
[1]*Charles F. Prichard	1906

Secretaries

*Henry Wurtz	1873
*Peter E. Demill	1874
*Charles H. Nettleton	1875-79
*William Henry White	1880-83
C. J. R. Humphreys	1884-91
A. B. Slater, Jr.	1892-96
Alfred E. Forstall	1897-04
Geo. G. Ramsdell	1905-06

[1] Elected but did not serve owing to merger. * Deceased.

OHIO GAS LIGHT ASSOCIATION

1884–1906

Presidents

*Gen. A. Hickenlooper	1884-86	*Jerome Penn	1897
Emerson McMillin	1887	W. C. Boyle	1898
*Eugene Printz	1888	*B. P. Holmes, elected for	1899
*Thomas Wood	1889	*E. H. Jenkins	1899
*Edw. Lindsley	1890	A. P. Lathrop	1900
*Chas. R. Faben, Jr	1891	George Whysall	1901
*H. Wilkiemeyer	1892	Henry L. Doherty	1902
Chas. H. Welch	1893	C. W. Andrews	1903
Irvin Butterworth	1894	John D. McIlhenny	1904
J. W. R. Cline	1895	F. W. Stone	1905
*Jos. Gwynn	1896	Donald McDonald	1906

[1]*B. W. Perkins.............. 1907

Secretaries

*Joseph M. Bate	1884-85	Alanson P. Lathrop	1894-98
Irvin Butterworth	1886-93	Thomas Clive Jones	1899-1906

WESTERN GAS ASSOCIATION

1878–1906

Presidents

*J. O. King	1878-80	*E. H. Jenkins	1894
*Thomas Butterworth	1881-82	Isaac C. Baxter	1895
*J. B. Howard	1883-84	A. W. Littleton	1896
T. G. Lansden	1885	*W. H. Odiorne	1897
*James Somerville	1886	James T. Lynn	1898
*John Fullagar	1887	*G. Treadway Thompson	1899
Emerson McMillin	1888	William McDonald	1900
Geo. G. Ramsdell	1889	I. C. Copley	1901
*E. G. King, Elected for	1890	Thomas D. Miller	1902
*Charles R. Faben, Jr	1890	A. H. Barret	1903
Frederic Egner	1891	F. H. Shelton	1904
E. G. Cowdery	1892	O. O. Thwing	1905
*B. E. Chollar	1893	Paul Doty	1906

[1]*Kerr Murray Mitchell......... 1907

Secretaries

*Lee A. Hall	1878-82	James W. Dunbar	1895-1906
A. W. Littleton	1882-94		

[1] Elected but did not serve owing to merger. * Deceased.

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COMMITTEES AND SUBCOMMITTEES.

1914-1915

GENERAL

Affiliation

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W. F. Barrett, L. R. Dutton,
H. C. Blackwell, S. J. Glass.

Arrangements

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G. G. Ramsdell, Secretary.
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E. C. Jones, C. O. G. Miller.
J. B. Klumpp,

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G. S. Barrows, G. T. Macbeth.

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Paul Doty,

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A. E. Forstall, Chairman.
C. H. Graff, J. B. Klumpp.

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J. M. Morehead, Secretary.
W. A. Baehr, E. C. Jones,
Paul Doty, T. D. Miller,
O. N. Guldlin, O. O. Thwing.

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J. S. DeHart, J. H. Taussig,
W.H.Fulweiler, H. L. Underhill.

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Supplying Large Buildings with Gas

O. H. Fogg, Chairman.
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D.E.Keppelmann, J.D vonMaur,
J. S. McIlhenny, R. C. Ware.
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H. L. Doherty

Accounting

Lewis Lillie, Chairman.
H. M. Brundage, S. J. Glass,
G. W. Curran, M. W. Stroud.

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President.

Report of the Proceedings

of the

American Gas Institute

Tenth Annual Meeting

held at

San Francisco, California

September 28, 1915.

INSTITUTE MEETING.

Tuesday, September 28.

The tenth annual meeting of the American Gas Institute was called to order in the auditorium of the Native Sons' Hall, San Francisco, California, September 28, 1915, at 2:30 P. M. by the President, Mr. E. C. Jones, Mr. George G. Ramsdell being in the Secretary's chair.

Upon motion, the reading of the minutes, was dispensed with.

THE PRESIDENT: Gentlemen, I welcome the members of the American Gas Institute to San Francisco, and it gives me a great deal of pleasure to call to order the tenth annual meeting of the American Gas Institute.

We have instructed the man who manufactures the weather, and the good people of California, to open wide the valves which supply sunshine and good fellowship.

The first business is the report of the Board of Directors.

THE SECRETARY: As the report was printed in the September Institute *News,* I will read only the changes that have been made since that time.

(The portions read by the Secretary are indicated by a star (*) in front of the headings.)

REPORT OF THE BOARD OF DIRECTORS.

OCCURRENCES OF PAST YEAR.

Meetings.

Meetings were held December 10th, January 14th, February 11th, March 17th, April 15th, May 13th, June 10th, July 13th, September 2nd and September 27th. All these occurred at Institute headquarters, except that of September 2nd held in Philadelphia, that of September 27th held in San Francisco, and those of March 17th and April 15th, held in Chicago and Philadelphia, respectively, in order that the Directors might attend the meetings of the Illinois and Pennsylvania Gas Associations. Both of these meetings were thoroughly justified as increasing the ties that bind the Institute to the two State associations, and the meeting in Chicago was especially valuable in the opportunity afforded to the western Directors to attend a Board meeting. The incoming Board should consider carefully whether the precedent thus set should not be again followed with possible changes in the associations visited.

The minutes of all the meetings have been published in the *News,* and only events of major importance, or recommendations requiring approval by the Institute, are included in this report.

Bulletin of Abstracts.

The publication of the *Bulletin of Abstracts* has been continued. The thanks of the Institute are due to The United Gas Improvement Company for furnishing the material for these abstracts.

**Life Membership of Frederic Egner.*

The Board takes pleasure in announcing the election to Life Membership, without payment of fee, of Mr. Frederic Enger, as a fitting reward to a life of effort for the benefit of the gas industry.

Accounts.

During the year the account books of the Institute have been placed on an income and expense basis, so that each month the earnings and expenses are accurately, known, and all future annual reports will show the exact income and expense applicable to the year, instead of as in the past, only the cash receipts and disbursements.

Deficit.

Mainly due to the increased expense of publishing the enlarged PROCEEDINGS incident to the sectional meetings of 1913 and 1914, there was a deficit this year of approximately $5000. This was nearly met by subscriptions from various gas companies, and the Board expresses its sense of obligation to the donors.

Affiliation.

The past year has witnessed an increase in the local gas associations affiliated with the Institute. The New Jersey State Gas Association signed an affiliation agreement as of September 1st. The Pennsylvania and Illinois Gas Associations terminated their old agreements and signed new ones as of September 1st. All of these agreements were ratified by the Board on September 2nd, and conform to the existing constitutional requirements as to affiliation, but are so worded that the local association is enabled to take advantage, if it so desires, of any further change in affiliation conditions.

**Committee Work.*

The Technical Committee, through its various subcommittees, has been doing some very valuable work preliminary to standardizing and improving lines of gas practice. Standardization of practice never was so important as in these days of commission control, and yet much diversity exists merely because no one has had time to devote the research required to demonstrate the one best way. Chemical and Physical Tests, Housepiping, Meter Connections, and Cast Iron Pipe Joints are all being investigated from this standpoint, and every Institute member, and the industry in general, will benefit largely from the results. Accident Prevention, Carbonization, and Gas Works Auxiliaries are covered by good reports, while Refractory Materials shows another year of fine progress.

The Public Relations Committee has continued its important task of acting as skilled adviser in the interests alike of consumers and sellers of gas, in the settlement of the many questions which arise between the latter and the public service commissions. Its services are freely drawn on by the Bureau of Standards, and in this connection, and also to meet a need felt in other quarters, it has formed a subcommittee on Installation, Regulation and Safety Code.

All of the committee reports have been approved by the Board and will be presented to the Institute meeting. Because lack of time will prevent any discussion from the floor, written comments will be obtained and embodied with the reports in the PROCEEDINGS. These reports should be carefully studied by each member and any suggestions promptly forwarded to the respective committees.

The Board does not want to leave this subject without stating that the work waiting to be done by the Institute is far greater than the capacity of the working force, both paid and unpaid, available at present, and in consequence important matter must be neglected either wholly or in part.

RECOMMENDATIONS.

Standardization of Special Threads.

At the instance of our then Committee on the Utilization of Gas Appliances, the American Society of Mechanical Engineers appointed a Committee on the Standardization of Special Threads for Fixtures and Fittings, to standardize the threads on brass pipe and tubing. Their report has been accepted by the Mechanical Engineers, and approved by our committees on Gas Lighting and on Gas Fuel Appliances, by the Technical Committee, and the Board endorses it and recommends that the Institute adopt these standards.

Amendments to Constitution.

(Unless otherwise shown, all matter in parentheses to be dropped; all matter in italics to be inserted.)

SECTION 3. The membership of the Institute shall consist of Honorary (Members), Active (Members), Junior (Members and), Associate *and affiliated* Members. Honorary (Members), Junior (Members) and Associate Members shall not be entitled to vote except in Section meetings as provided in Section 39 hereof, nor to hold office, but shall be entitled to all the other privileges of membership. *Affiliated Members shall be entitled to attend and take part in all meetings of the sections and the Institute, but shall have no voting privileges, and shall receive publications of the Institute only as provided in Section 56.*

Reason for Change: To provide for Affiliated Members in accordance with the report of the Committee on Affiliation.

SECTION 8. (Charter Members shall be such of the present membership of the American, Ohio or Western Gas Associations as shall be certified by the officers of the same to the Directors of the Institute as qualified respectively for Active, Junior or Associate Membership, provided that to become a Charter Member, it shall be necessary for each person so certified to make application to the Directors of the Institute within a period of sixty days after notice has been sent him of the formation of the Institute.) *To be eligible as an Affiliated Member, a person must be a member of an association affiliated with the Institute in accordance with Section 55.*

Reason for Change: The existing section is no longer needed, and by its omission to make way for the new section required by the proposition for Affiliated Members, the renumbering of all the succeeding sections is obviated.

SECTION 10. Every application for either Active, Junior or Associate Membership shall be made to the Secretary in writing upon a form approved by the Directors, upon which shall be set forth as the grounds of the application, a complete account of the qualifications and experience of the applicant and his agreement to conform, if elected, to the Constitution, By-Laws and Rules of the Institute. Each applicant must be endorsed by at least two Active Members to whom he is personally known. The Secretary shall submit each application to the Membership Committee, who shall consider and act upon it and assign the applicant to the grade of membership to which, in their judgment, his qualifications entitle him. The name of each candidate thus approved by the Membership Committee, unless objection is made by the applicant, shall, after approval by the Directors be submitted to the voting membership for election by means of a letter ballot. *Every application for Affiliated Membership shall be accompanied by the dues and be endorsed by the Secretary of the affiliated association. Every applicant complying with these requirements shall be notified by the Secretary of his enrollment as an Affiliated Member.*

Reason for Change: To provide for Affiliated Members.

SECTION 11. It shall be competent for any Junior (or), Associate *or Affiliated* Member to apply for transfer to another grade of membership. The application for such transfer shall be made in the same manner as in the case of a new applicant.

Reason for Change: To provide for Affiliated Members.

SECTION 13. Any person elected to the Institute *shall agree to comply with the requirements of the Constitution and*, except *in the case of* Honorary Members (must) *shall* (subscribe to the Constitution and) pay to the Treasurer the initiation fee and one year's dues for his grade of membership before he can be entitled to the rights and privileges, or can receive a certificate of membership. If this requirement is not complied with within six months of the notification of the election, the applicant shall be deemed to have declined the election and the election shall be void.

Reason for Change: To make the Constitution agree with actual practice.

SECTION 15. (A Junior Member, on promotion to any other grade of membership, shall pay an additional fee of $10.00.) *Any member on being transferred to any other grade of membership shall pay either the full initiation fee of the grade to which he is transferred or the difference between that initiation fee and the one he has already paid,* except that Charter Junior Members shall not be required to pay such additional fee. No person shall retain Junior Membership for more than two years after becoming qualified for Active Membership.

Reason for Change: To care for the transfer of Affiliated Members.

SECTION 16. The annual dues, payable in advance, for membership in each grade shall be as follows:

For Active Members	$15.00
For Associate Members	15.00
For Junior Members	7.50
For Affiliated Members	2.00

Reason for Change: To provide for Affiliated Members.

SECTION 18. The Directors shall have power by letter ballot to admit to Life Membership, without payment of a Life Membership fee, any person who for a long term of years has been an Active or an Associate Member, when, for special reasons, such an action would, in their judgment, promote the best interests of the Institute. Notice that such action (as) *is* proposed shall have been given at a previous meeting of the Directors, and one dissenting vote shall defeat the proposed action.

Reason for Change: To correct a typographical error.

*Suspensions and Expulsions.

SECTION 19. Any member may retire from membership by giving written notice to that effect to the Secretary, and paying all dues to date, unless released from said payment by a vote of the Directors. A member whose dues for a year completely expired are not paid, shall not be entitled to vote, nor to participate in the deliberations of the Institute, nor to receive a copy of (the PROCEEDINGS) *its publications.* Any member whose dues shall remain unpaid for a term of three years may be dropped from the roll of membership by a vote of the Directors. A member dropped for non-payment of dues, may upon paying the amount he owes the Institute, be reinstated at the option of the Directors.

Reason for Change: To improve present practice.

SECTION 24. Should a vacancy occur in the Board of Directors or in any elective office, except (the Presidency or First Vice-Presidency) *that of President or Vice-Presidents,* through death, resignation or other cause, the Directors may elect an Active Member to fill the vacancy until the next annual election.

Reason for Change: Under the existing Constitution, there is no First Vice-President.

SECTION 26. The Board of Directors shall present at the annual meeting of the Institute a report verified by the President, Secretary and Treasurer, or by a majority of the members, which shall show the state of the finances of the Institute at the date of the report; the receipts and expenditures for the fiscal year immediately preceding; the names and places of residence of the persons who have been admitted to membership in the Institute during that year, and give an account of the action taken by the Directors upon matters coming before (it) *them* and recommendations as to the action to be taken by the Institute. This report shall be filed with the records of the Institute and an abstract of it shall be entered in the minutes of the proceedings of the annual meeting.

Reason for Change: To correct a grammatical error.

SECTION 27. At each annual meeting there shall be elected from among the Active Members, a President, a Vice-President for each section into which the Institute is at the time divided, a Secretary, a Treasurer, and, until otherwise provided for, five (members of the Board of) Directors. All of the officers shall be elected for one year (but the members of the Board of) *except the* Directors, *who* shall be elected for two years.

Reason for Change: To improve the wording.

SECTION 31 (Previous to each annual meeting, it shall be the duty of the Directors to appoint a Nominating Committee of five members, none of whom shall be a Director. It will be the duty of this Nominating Committee to present at the annual meeting a list of the Active Members and Directors whom they recommend as officers for the ensuing year. It must select the Vice-President for each section from three Active Members, to be chosen by a majority vote of that section at the preceding annual meeting.) *At least four months previous to each annual meeting, it shall be the duty of the Directors to appoint a Nominating Committee of five members, none of whom shall be a Director. It shall be the duty of this Nominating Committee to report to the Secretary on, or before, July 15th, a list of the Active Members whom they recommend for election as Officers and Directors for the ensuing year. The Nominating Committee must select the Vice-President for each section from three Active Members, to be chosen by a majority vote of that section at the preceding annual meeting. The report of the Nominating Committee shall be published in full by the Secretary in the number of the "Gas Institute News" for August, or separately, if necessary, at the discretion of the Secretary, and a copy of this number of the "News," or said separate circular, shall be mailed to each member entitled to vote not later than August 5th. Immediately following the report shall be printed in full Section 32 of the Constitution.*

Reason for Change: To provide for a new method in making nominations in accordance with the report of the Committee appointed to amend the provisions of the Constitution relating to the nomination of officers. It will be noted that there is no restriction in the Constitution limiting the Vice-President of a section to a member registered in that section. Possibly such restriction was not intended, and if because of other changes in the Constitution, registration is done away with, of course, the restriction is not needed.

SECTION 32. (Twenty or more members entitled to vote may constitute themselves a special nominating committee with the same powers as the Nominating Committee appointed by the Directors.) *Any twenty, or more, members entitled to vote may constitute themselves a Special Nominating Committee and may prepare a ticket in entire, or partial, opposition to the ticket prepared by the Nominating Committee, except that the nominee for Vice-President in each section must be selected from three Active Members, chosen by a majority vote of that section at the preceding annual meeting. Any such ticket shall be fully filled out with the names of the candidates for all of the offices and positions of Directors to be filled at the approaching election, by inserting the names of the nominees of the regular Nominating Committee where there are no opposing candidates nominated. Any such ticket must reach the Secretary on or before September 15th, and shall be published by him in full, together with the full list of members of such Special Nominating Committee, in the number of the "Gas Institute News" for October, or separately, if necessary, at the discretion of the Secretary, and a copy of this number of the "News," or such separate circular, shall be mailed to each member of the Institute entitled to vote not later than October 5th. Only such tickets as may be nominated in accordance with Sections 31 and 32 shall be considered at the annual meeting.*

Reason for Change: Same as for Section 31.

SECTION 35. In the absence of the President, one of the Vice-Presidents shall take the chair; if more than one Vice-President be present in the absence of the President, the Vice-President to preside shall be determined by lot, and in the absence of the President and Vice-President, a Chairman shall be appointed by the Directors from among their own (members) *number.* Each Vice-President shall be the presiding officer of the section for which he was designated on nomination. He shall be *ex-officio* member of each committee relating solely to the work of his section.

Reason for Change: To improve the wording.

SECTION 36. (The duties of the Secretary shall be to take minutes of all proceedings of the Institute and of the Board of Directors and to enter them in proper books for that purpose.) *The Secretary shall be present at all meetings of the Institute and of the Board of Directors, and shall take and keep the minutes thereof.* He shall conduct the correspondence of the Institute, read minutes and notices of all the meetings and also such papers and communications as are considered in the absence of their authors, and perform whatever other duties may be required *of him* (in) *by* the Constitution and By-Laws (appertaining to this department). There also shall be a Secretary for each section, to be appointed by, *and having the same term of office as,* the Chairman of the section (and with the same term of office). His duties shall be in general to assist in conducting the meetings of his section.

Reason for Change: To improve the wording.

SECTION 37. (The duties of the Treasurer shall be to receive and keep all annual dues and funds of the Institute, to keep correct accounts of same, and pay all bills approved by the President and a member of the Finance Committee, and he shall make an annual report to be submitted to the Institute.) *The Treasurer shall collect and have charge of all funds of the Institute. He shall pay all bills approved by the President and a member of the Finance Committee, and shall keep book accounts of all receipts and expenditures. He shall make an annual report.*

Reason for Change: To improve the wording.

SECTION 39. The duties of the Directors shall be to have the general management of the affairs of the Institute, and to prepare for its meetings. No paper or report that has not had the approval of the Directors shall be read at any meeting of the Institute or any section thereof.

The Directors shall have the power to appoint, from time to time, a Committee on Arrangements from among the members, to assist the (Board of) Directors in arranging for the meetings of the Institute. (The Directors shall have power to fill for the unexpired term, any vacancies occurring by death or resignation in their own number, or in the general committees.) The Directors shall have power to provide for the voluntary division of the membership into two or more sections for the choice of sectional Vice-Presidents and for the hearing and discussion of papers and reports. The functions and powers of (such sections) *each section* shall be limited to the nomination of a Vice-President, the (providing) *provision* and consideration of papers and reports, the reference to committees, and to recommendations to the Institute or to the Board of Directors. Any member of the Institute may attend the meeting of any section at any time. Any *Honorary,* Active, (or) Associate *or Junior* member *in good standing* may vote on (section matters) *the election of section officers or on other matters connected with section organization* in one section only, and to so vote must register as a voting member of such section. He may change this registration on one year's notice to the Secretary of the Institute, *provided that this notice be waived in the case of each member making application to form a new section.*

Upon the written application to the Directors of any thirty members of the Institute asking for the creation of a new section, the Directors shall proceed to form the section applied for.

Any resolution, report or recommendation that has not been considered and approved by the Directors, and that in the opinion of the Chair would have the effect of changing the policy of the Institute, or committing it to any new policy or opinion to which it had not theretofore been committed, (should) *shall* be referred, before adoption, to the Board of Directors, whose duty it shall be to report to the next regular meeting of the Institute upon such committal, if any, and its proper phrasing.

Reason for Change: The clauses inserted better define the conditions under which a member may vote on section matters, and also enable the formation of new section without waiting for one year.

SECTION 40. There shall be two general committees, each reporting to the Board of Directors and responsible to the Board for such part of the work of the Institute as is delegated to it in accordance with Sections 34, 41 and 42. Each Committee shall be composed of at least six members, appointed each year by the (President-elect) ***President after the annual meeting,*** (and) ***to*** serve one year.

Reason for Change: To improve the wording.

SECTION 45. The Secretary shall send notices to all members of the Institute at least fourteen days before each general meeting, mentioning the papers to be read and any special business to be brought before the meeting. During a recess in any meeting of the Institute, taken in order that section meetings may occur, no meeting of the Institute other than as provided at the time the recess is ordered, shall be held until one hour after a call for such meeting has been read in each section meeting ***in session*** at the time (in session), and has been posted on the official bulletin board. The President shall have the authority to issue such call, and it shall be obligatory on him to issue such call on the written request of fifty members.

Reason for Change: To improve the wording.

SECTION 50. Any member, with the concurrence of the presiding officer, may admit a friend to each meeting ***of a section or*** of the Institute, but such person shall not take part in any of the discussions unless permission to do so be given by the meeting.

Reason for Change: To care for an omission in last year's revision.

SECTION 51. All papers read at the meetings of the Institute must relate to matters either directly or indirectly connected with the objects of the Institute (and must be approved by the Directors before being read).

Reason for Change: The clause to be stricken out is a repetition of a clause in Section 39.

SECTION 53. The Past-President, the Junior Past-President, (the First Vice-President) the Junior Past-Chairmen of the two general committees, and the Secretary shall constitute a Publication Committee, and nothing shall be included in the published reports of the Institute's PROCEEDINGS, or in any other publication issued by its authority, that has not been approved by at least (two-thirds) *three-fifths* of the full membership of the Publication Committee.

Reason for Change: The same as for Section 24.

SECTION 55. (Clause A) The Board of Directors may in its discretion make with any gas, electric, or gas and electric association, an affiliation agreement, upon such terms as may be mutually agreed upon, providing the membership or objects or interest of such association are not in conflict with those of the Institute. An affiliation agreement shall provide for the termination of such agreement on twelve months' notice by either party.

An affiliation agreement may provide for representation of the affiliated association on the Board of Directors of the Institute, but in such cases said association shall at no time have more than 20 per cent. of its voting membership persons not directly identified with gas or electric interests within the state or district designated by the name of the Association; and said association shall agree to present the result of work of interest in the form of a report to the Board of Directors of the Institute; such affiliated Associate Directors shall be additional to the Institute Directors provided for in Section 23, and shall at no time exceed one-third of the total.

On all matters pertaining to public relations, the Institute and the affiliated association shall agree to co-operate, and the latter shall consult with and be advised by the Public Relations Committee before taking official action on these matters. The services of the Public Relations Committee shall be *available to the affiliated association in return for payment of actual expenses incurred.*

Upon request of the affiliated association, the Technical Committee will co-operate in all matters within its province. Abstracts of papers presented to the affiliated association will, after approval by the Technical Committee, be published in the "News," as will complete papers undertaken by agreement with the Technical Committee.

Reason for Change: To care for certain recommendations in the report of the Committee on Affiliation.

(PROCEEDINGS) *Publications.*

SECTION 56. *With the exception of Affiliated Members,* each member of the Institute in good standing shall be entitled to and shall be furnished by the Secretary with a copy of the PROCEEDINGS of the Institute for the current year, in which shall be listed the names and addresses of the members. In any such list, each member (should) *shall* be listed by the title, or titles, only, from which he derives his eligibility to his class of membership. *Affiliated Members shall, in return for their dues, receive the "Gas Institute News," and at members' prices, any other publications of the Institute.*

Reason for Change: To provide for Affiliated Members.

SECTION 57. (All propositions) *Any proposition* for adding to or altering any of the provisions of the foregoing Constitution shall be laid before the Directors, who, if they see fit, may bring it before the next general meeting of the Institute, and who shall be bound to do so on the requisition in writing of any ten members of the Institute. All such propositions shall be decided by ballot and shall require two-thirds of the vote cast for their adoption.

Reason for Change: To improve the wording.

THE PRESIDENT: The report of the Board of Directors is now in your hands. What is your pleasure?

MR. G. I. VINCENT (Des Moines): I move the report be adopted as read.

(Motion seconded and carried.)

REPORT OF THE SECRETARY AND TREASURER.

REPORT OF COMMITTEE ON SECURING NEW MEMBERS.

The list of new members elected during the year has been as follows:

On the March ballot—	
Active	19
Associate	6
Junior	13—38
On the September ballot—	
Active	17
Associate	6
Junior	8—31
Total	69

H. C. BLACKWELL, *Chairman,*
W. A. BERTKE,
A. W. BORDEN,
F. A. CRESSEY, JR.,
C. E. REINICKER.

(The names of the members elected on the March and September ballots are not shown here, as the dates of their election are indicated on the Membership List.

The list of members present at the meeting will also be found in the same list, designated by the letter "P.")

TREASURER'S REPORT.

September 11, 1915.

MR. E. C. JONES, *President,*
American Gas Institute,
29 West 39th St.,
New York City.

DEAR SIR:

I have the honor to report that I have audited the cash accounts of the American Gas Institute for the period of twelve months ended August 31, 1915, and have found the same to be correct.

I verified that all receipts for the entire year as shown by the cash book had actually been deposited; that all disbursements have been duly authorized and were covered by properly approved vouchers; and further tested the correctness of the payments by examining certain of the vendors' invoices. A certificate was obtained from the bank confirming the balance on deposit as shown by your records as of August 31, 1915. The petty cash on hand was counted and found to be correct.

In addition to the detailed audit of the cash, tests were made of the subsidiary records, and I was fully satisfied as to their accuracy.

In my opinion the annexed schedule presents a correct statement of the cash receipts and disbursements of the period under review.

Very truly yours,

CHESTER P. CHILD,
Certified Public Accountant.

MEMBERSHIP REPORT.

Total members, August 31, 1914		1,528
New members elected on March and September ballots		69
		1,597
Members deceased	9	
Members resigned	22	
Members dropped for delinquency	30	
Members did not accept election	10	
		71
		1,526

AMERICAN GAS INSTITUTE. COMPARATIVE STATEMENT OF CASH RECEIPTS AND DISBURSEMENTS.

Periods of twelve months ended 31st August 1915 and 1914.

	Period ended 31st August 1915			Period ended 31st August 1914		
Cash balance on hand at commencement of period			$ 1,191.23			$ 4,313.82
Receipts:						
Dues: Arrears	$ 1,470.00			$ 1,585.00		
Current	12,330.00			12,120.00		
Advance	25.00			20.00		
		$13,825.00			$13,725.00	
Initiation fees		1,335.00			1,970.00	
Sales: Gas Institute News	2,955.30			2,987.13		
Bulletin of Abstracts	1,557.98			1,797.42		
Proceedings	413.99			527.00		
Badges	52.75			79.75		
Miscellaneous	2,673.05			877.88		
		7,653.07			6,269.18	
Rent (Society of Gas Lighting)		60.00			60.00	
Deficiency Fund		4,320.00			—	
Interest on bank balances		81.67			153.45	
Reimbursement for rebinding books damaged by rain		103.20			—	
Total receipts for period			$27,377.94			$22,177.63
Disbursements:						
Office Expenses:						
Salaries: Secretary	3,999.96			3,999.96		
Assistant to secretary	1,200.00			1,160.00		
Stenographer	685.00			698.00		
Rent of office and storeroom	1,830.66			1,917.95		
Supplies, equipment, postage, etc.	690.62			946.43		
Telephone and telegraph	152.12			163.02		
Library	138.30			16.60		
Insurance	49.31			40.00		
Miscellaneous	241.23			235.69		
		8,987.20			9,177.65	
Balance on hand at commencement of period and total receipts carried forward			$28,569.17			$26,491.45
Disbursements carried forward		$ 8,987.20			$ 9,177.65	

American Gas Institute. Comparative Statement of Cash Receipts and Disbursements.

Periods of twelve months ended 31st August, 1915 and 1914.—(*Concluded.*)

	Period ended 31st August, 1915				Period ended 31st August, 1914			
Balance on hand at commencement of period and total receipts brought forward				$28,569.17				$26,491.45
Disbursements brought forward			$ 8,987.20				$ 9,177.65	
Disbursements:—(Concluded.)								
Publishing and Distributing:								
Proceedings		$6,939.78				$6,294.52		
Gas Institute News	$3,149.27				$2,472.29			
Supplements	—				1,821.89			
Prizes	75.00				50.00			
		3,224.27				4,344.18		
Bulletin of Abstracts		1,681.79				1,629.92		
Advance Papers		1,686.33				886.42		
Certificates		27.75				56.60		
Merchandise		2,748.56				518.74		
			16,308.48				13,730.38	
Meetings and Miscellaneous:								
Expense annual meeting	54.25				1,157.99			
Less, refund by committee on arrangements	—				975.79			
	54.26				182.20			
Reporting	981.20				734.55			
		1,035.45				916.75		
Expense directors' meetings	538.57							
Traveling expenses	105.55							
		644.12				379.91		
Stationery and expenses—committees		269.14				254.53		
Badges		41.00				2.00		
Gas Congress		87.49				205.00		
Gas educational fund		500.00				500.00		
International Committee on Illuminations		—				100.00		
National Committee on Electrolysis		200.00				—		
National Fire Protection Association		25.00				25.00		
Illuminating Engineering Society		5.00				—		
National Commercial Gas Association		5.00				—		
Rebinding books damaged by rain (refunded)		91.20				—		
Refunds		8.50				9.00		
			2,911.90				2,392.19	
Total disbursements for period				$28,207.58				$25,300.22
Cash balance at end of period:								
Columbia Trust Company			311.59				1,141.23	
Petty cash on hand			50.00				50.00	
				$ 361.59				$ 1,191.23

AMERICAN GAS INSTITUTE. COMPARATIVE STATEMENT OF CASH RECEIPTS AND DISBURSEMENTS.

Periods of twelve months ended 31st August 1915 and 1914.

	Period ended 31st August 1915			Period ended 31st August 1914		
Cash balance on hand at commencement of period			$ 1,191.23			$ 4,313.82
Receipts:						
Dues: Arrears	$ 1,470.00			$ 1,585.00		
Current	12,330.00			12,120.00		
Advance	25.00	$13,825.00		20.00	$13,725.00	
Initiation fees		1,335.00			1,970.00	
Sales: Gas Institute News	2,955.30			2,987.13		
Bulletin of Abstracts	1,557.98			1,797.42		
Proceedings	413.99			527.00		
Badges	52.75			79.75		
Miscellaneous	2,673.05	7,653.07		877.88	6,269.18	
Rent (Society of Gas Lighting)		60.00			60.00	
Deficiency Fund		4,320.00			—	
Interest on bank balances		81.67			153.45	
Reimbursement for rebinding books damaged by rain		103.20			—	
Total receipts for period			$27,377.94			$22,177.63
Disbursements:						
Office Expenses:						
Salaries: Secretary	3,999.96			3,999.96		
Assistant to secretary	1,200.00			1,160.00		
Stenographer	685.00			698.00		
Rent of office and storeroom	1,830.66			1,917.95		
Supplies, equipment, postage, etc.	690.62			946.43		
Telephone and telegraph	152.12			163.02		
Library	138.30			16.60		
Insurance	49.31			40.00		
Miscellaneous	241.23	8,987.20		235.69	9,177.65	
Balance on hand at commencement of period and total receipts carried forward			$28,569.17			$26,491.45
Disbursements carried forward		$ 8,987.20			$ 9,177.65	

AMERICAN GAS INSTITUTE. COMPARATIVE STATEMENT OF CASH RECEIPTS AND DISBURSEMENTS.

Periods of twelve months ended 31st August, 1915 and 1914.—(*Concluded.*)

	Period ended 31st August, 1915				Period ended 31st August, 1914			
Balance on hand at commencement of period and total receipts brought forward				$28,569.17				$26,491.45
Disbursements brought forward			$ 8,987.20				$ 9,177.65	
Disbursements:—(Concluded.)								
Publishing and Distributing:								
Proceedings		$6,939.78				$6,294.52		
Gas Institute News	$3,149.27				$2,472.29			
Supplements	—				1,821.89			
Prizes	75.00				50.00			
		3,224.27				4,344.18		
Bulletin of Abstracts		1,681.79				1,629.92		
Advance Papers		1,686.33				886.42		
Certificates		27.75				56.60		
Merchandise		2,748.56				518.74		
			16,308.48				13,730.38	
Meetings and Miscellaneous:								
Expense annual meeting	54.25				1,157.99			
Less, refund by committee on arrangements	—				975.79			
	54.26				182.20			
Reporting	981.20				734.55			
		1,035.45				916.75		
Expense directors' meetings	538.57							
Traveling expenses	105.55							
		644.12				379.91		
Stationery and expenses—committees		269.14				254.53		
Badges		41.00				2.00		
Gas Congress		87.49				205.00		
Gas educational fund		500.00				500.00		
International Committee on Illuminations		—				100.00		
National Committee on Electrolysis		200.00				—		
National Fire Protection Association		25.00				25.00		
Illuminating Engineering Society		5.00				—		
National Commercial Gas Association		5.00				—		
Rebinding books damaged by rain (refunded)		91.20				—		
Refunds		8.50				9.00		
			2,911.90				2,392.19	
Total disbursements for period				$28,207.58				$25,300.22
Cash balance at end of period:								
Columbia Trust Company			311.59				1,141.23	
Petty cash on hand			50.00				50.00	
				$ 361.59				$ 1,191.23

STATEMENT OF OUTSTANDING ACCOUNTS.

Dues.

Three Years				
Active,	25			
Associate,	2	27	@ $30.00	$810.00
Junior,	4		@ 15.00	60.00
Two Years				
Active,	45			
Associate,	6	51	@ 20.00	1,020.00
Junior,	13		@ 10.00	130.00
One Year				
Active,	122			
Associate.	20	142	@ 10.00	1,420.00
Junior,	27		@ 5.00	135.00
				$3,575.00

Abstracts.

1915			
10 Subscriptions	@ $ 5.00	$ 50.00	50.00
Mdse. a/c Sales Book			76.10
3 News Subscriptions	@ $ 2.00	$ 6.00	
9 News Subscriptions	@ 2.00	18.00	
1 News Subscription	@ 1.00	1.00	25.00
			$3,726.10

Proceedings.

Volumes 1, 2, 3, 4, 5, 6	
In stock Sept. 1, 1914	1,126
Sold during year	3
On hand	1,123
Volume 7, 1912	
In stock Sept. 1, 1914	278
Sent out and sold during year	5
On hand	273
Volume 8, 1913	
In stock Sept. 1, 1914	387
Sent out and sold during year	14
On hand	373
Volume 9, 1914	
In stock	412
Sent out and sold during year	69
On hand	343

Badges, 1915.

On hand Sept. 1, 1914	118
Sold during year	15
On hand	103

REPORT OF FINANCE COMMITTEE.

To the Directors of the American Gas Institute:

GENTLEMEN:

Enclosed please find the report of the Treasurer for the fiscal year ending August 31, 1915.

Your Finance Committee has had the books, accounts and statements of the Treasurer audited by Chester P. Child, certified public accountant, and he has found the Treasurer's report to be correct. We attach hereto a copy of his report.

Following up the suggestion made last year in the report of the Finance Committee, there has been installed a system of accounts by means of which the true income and expenses can be obtained at any time during the fiscal year and be shown in full at the end of each year. This system will be in force during the whole of the fiscal year which began September 1, 1915.

Early in the year it was seen that the deficit alluded to in the report last year would amount to nearly $5,000. Following your instructions, that an attempt be made to raise the money required to meet this deficit by requesting subscriptions from the gas companies, employees of which were members of the Institute, letters were sent to all such companies asking each to pay a definite sum based upon its sales of gas. In answer to these letters subscriptions have been received from sixty-one gas companies, eight of which paid over $100, six $100, thirteen from $50 to $75, and thirty-four less than $50 each. The total amount raised in this way has been $4,570, of which $250 has been received since the end of the fiscal year. The total does not quite equal the deficit.

The increase in dues going into effect for the current fiscal year should enable the Institute to meet its expenses without calling for any extraordinary subscriptions.

Respectfully submitted,

ALFRED E. FORSTALL, *Chairman,*
CARL H. GRAF,
J. B. KLUMPP.

THE PRESIDENT: The next order of business is the President's address, and I will ask your Vice-President to take the Chair.

(Vice-President Walton Forstall takes the Chair.)

PRESIDENT'S ADDRESS.

The year 1915 is a period of unusual happenings, and the American Gas Institute is holding its tenth annual meeting in San Francisco on the shores of the Pacific Ocean, is justifying its claim of including the whole United States in its field of activities. This is the first time in the life of our industry that an American gas association has held a meeting west of Denver, and if we think for a moment, the reason becomes clear.

Ours is a busy fraternity dealing with the manufacture and distribution of a product still mysterious and little understood by the public, and it is only the unceasing vigilance of the gas engineer which ensures uninterrupted service. The active, alert men of the gas business cannot travel far from the scene of their duty, and a trip to California is an event of a lifetime. To fully appreciate the distance traveled by most of our members to attend this meeting, it is necessary to study a map of the world.

San Francisco, is nearly 3,300 miles from New York. If the points of a pair of compasses are placed on New York and San Francisco, and the distance is used as the radius of a circle with London as its center, the circle includes the whole of Newfoundland, part of Labrador, the whole of Greenland, all of Europe including a portion of Siberia, it reaches beyond Suez, and embraces about one-fifth of Africa. In other words, if a gas congress were held in London, it could be reached by everybody in Europe, Northern Africa, Greenland and Newfoundland, without traveling further than from New York to San Francisco. These facts are rather appalling, but they are more than equalled by the enthusiasm and fraternal spirit which bring this gathering of gas men together.

Our California is an empire in itself, and with its more than one hundred million acres of land, it would hold the entire population of the world with less than sixteen persons to an acre. I can see in the future an increasing industrial, agricultural and commercial importance which will bring California so near to the East that Gas Institute meetings in San Francisco will be necessary and frequent. The gas men of the Pacific Coast appreciate the honor of having this meeting in San Francisco, and it will redound to the credit of the Institute for proclaiming that its title of "American" covers the United States from ocean to ocean.

An innovation in Institute work was the appointment of a committee on "Collective Gas Exhibit" for the Panama-Pacific International Exposition, and had it not been for the effective efforts of your committee, our industry would not have been represented in this great world's exposition. The Collective Gas Exhibit occupies 10,000 square feet of floor space in the Palace of Manufactures, and is illustrative of the manufacture, distribution and uses of gas. The exhibit is lighted by gas, and is a convincing exponent of the economy and efficiency of gas illumination. The Grand Prize, which is the highest award in the gift of the Exposition, was awarded to the Collective Gas Exhibit; and on the special exhibitors day of the Manufactures and Varied Industries Palaces, the first prize, a silver loving cup, was awarded to the Collective Gas Exhibit for the most attractive and best decorated exhibit in the Palace of Manufactures. This unqualified success of an Institute committee dispels any unspoken thought that the Institute is not keenly alive to the growing importance and boundless possibilities of the gas business.

Your President urges a close study by the Captains of our industry of the report of your Public Relations Committee. This report discloses the fact that the work of this committee in the education of the public mind along economic lines has advanced the cause of gas in the betterment of service to the public, and the saving of waste to the manufacturer by intelligent regulation of the quality of our product.

**BRONZE MEDAL PRESENTED BY THE
PANAMA-PACIFIC INTERNATIONAL EXPOSITION
TO THE
AMERICAN GAS INSTITUTE.**

The work of this committee, together with the constructive and standardizing work of your Technical Committee, and the various co-operating sub-committees, places the American Gas Institute in the front rank of national engineering societies, and enhances the value of membership. A continuation of this work should be fostered and appreciated by the gas undertakings of this country to such an extent that our membership should be largely increased, and the Institute become a clearing house for the settlement of questions of policy relating to all departments of the gas business. This leads to the thought of the wisdom of continuing the life of active and important committees, engaged in progressive investigation.

On account of our participation in the International Gas Congress, the PROCEEDINGS of our tenth annual meeting will consist mainly of the reports of committees, and your Board of Directors has chosen this opportunity to prepare an index of the PROCEEDINGS of the past decade covering the life of the Institute, which will add materially to the value of our published PROCEEDINGS.

Your President has spent forty years of unfaltering devotion to the gas business, and thirty-six years to association work, and during that time, filled with its failures and successes, menacing competitions and triumphant advancement, no fear of the future glory of the gas business nor loss of faith in its eventual predominance has ever crept in.

The future of the gas business looks very bright; we are the purveyors of a commodity which has become a public necessity and before us lies a field of opportunities. We are dealing with British thermal units, and with a knowledge of their application, gas should be pre-eminent where heat, power or illumination is needed in domestic and industrial economy.

The success of our business depends upon the individuals engaged in its various departments, and a grave responsibility rests upon the men who are the framers of its destiny. An unshaken belief in the efficiency and economy of gas for all purposes is necessary to a permanent development of the business, and the agents must be gas men, not gas and electric men.

Gas and electricity cannot be well and impartially served by the same hand. While new extensions are necessary to expand our business as communities grow, the greatest and most fruitful field will be the development of new uses for gas among present consumers. As men must be the potent factors in the upbuilding of our industry, it rests with the gas associations of our country to educate the men, and therein lies a wide scope of usefulness for the American Gas Institute.

Death has taken eight of our members during the year, and it has been the custom to record the death of a member by inscribing his name and the date of his death on a memorial page in the PROCEEDINGS. While I do not approve of the ordinary eulogistic obituary notices, it seems to me that the dignity of membership in the American Gas Institute calls for more than passing notice, when it is terminated by the hand of death. I therefore recommend for your consideration the appointment of a committee on necrology, whose duty it shall be to prepare biographical notices of deceased members for publication in the PROCEEDINGS. These notices will have historical value, and if a man's life work has been of sufficient importance to recommend him to membership in the Institute, then a record of his work should be a valuable addition to the history of our industry.

(Prolonged applause.)

CHAIRMAN FORSTALL: It has been customary to appoint a Committee on President's Address to report at a subsequent meeting, but due to the fact that we will have but one session, there will not be sufficient time for the Committee to consider and present a report at this meeting. So, unless there is objection, the Chair will not appoint that committee until a later day, and will ask leave to have the report of the Committee embodied in the PROCEEDINGS of the Institute.

(For convenience the report of the committee is inserted at this place.)

REPORT OF THE COMMITTEE ON PRESIDENT'S ADDRESS.

Your Committee appointed to consider the address of the President reports as follows:

The address for the moment subordinates the technical to the more general elements of our business. It especially refers to the unusual circumstances attending the holding for the first time of a meeting of a national gas association on the Pacific Coast, and this in connection with the holding of an International Gas Congress.

Your Committee desires to call particular attention to the strikingly graphic way in which the comparison is made between holding an International Gas Convention in San Francisco and in London, and the distances that would have to be covered by those attending from different parts of the world.

The reference to the gas exhibit which was made a notable feature of the Exposition, and to the effective work of the Committee responsible for the splendid result obtained and the recognition on the part of the Exposition authorities of the high quality of this exhibit, is something in which we should all take special interest and honest pride.

Your Committee wishes to endorse with all proper emphasis Mr. Jones' recommendation to the "captains of our industry" that they should study carefully the report of our Public Relations Committee, to the end that the quality of service should be improved not only as opportunities offer but as opportunities can be devised; and that the public should be kept informed of all progress accomplished along these lines.

Throughout the address there is in evidence an enthusiasm for and a devotion to the gas business that we desire to recommend to the attention and loyalty of our members. As Mr. Jones states, there is in his mind "no fear of the future glory of the gas business, nor loss of faith in its eventual predominance." This earnest belief has had much to do with his own personal success, and is an element in achievement in all lines of endeavor which is worthy of being accepted as an example by all of our members and particularly by those who are still young in service.

All of which is respectfully submitted.

CHARLES H. NETTLETON, *Chairman,*
E. G. COWDERY,
ALEX C. HUMPHREYS.

(President Jones resumes the chair.)

THE PRESIDENT: I will now call for the report of the Trustees Gas Educational Fund:

SEVENTEENTH ANNUAL REPORT OF THE TRUSTEES GAS EDUCATIONAL FUND TO THE SUBSCRIBERS TO THE FUND.

To the Subscribers to the Trustees Gas Educational Fund:

GENTLEMEN: The Trustees appointed at the Twenty-sixth Annual Meeting of the American Gas Light Association, held October 17, 1898, to administer the Educational Fund formed by your subscriptions, submit the following report as to the work done from October 1, 1914, to September 30, 1915.

The membership in the class on September 30, 1915, shown by the report of the Secretary, is smaller than that at the same date last year. The latter, however, was the largest on any September 30th since 1909.

The demand for the "Catechism of Central Station Gas Engineering in the United States" has slackened, only eighty-nine copies having been sold during the year. The edition is, therefore, not exhausted as was anticipated at the beginning of the year would be the case, and there are still on hand sufficient copies to supply the same demand for another year. As shown by the report of the Treasurer, the proceeds of the sales up to September 30, 1915, have exceeded the expenses of publication and advertising by $3,087.25. Of this amount, $2,200 has been added to the surplus fund.

During the year, twenty members of the Section of 1915 finished their course and their connection with the class ceased, while the Section of 1918 started work on January 1, 1915, with a membership of twenty-eight, which has been maintained practically constant since that time, the new members coming in having offset those who resigned or were dropped because of failure to send in answers to the questions.

The number of members in each section at the beginning of the year, with the changes that have taken place, and the names of the members of the class who have completed the course during the year, are shown in detail on the Secretary's Report which is appended.

The Section of 1916 contains fifteen members, the Section of 1917 thirty-five and the Section of 1918 twenty-seven, making the total membership in the class seventy-seven.

The card index of the principal articles published in the *American Gas Light Journal, Gas Age,* and the *Journal of Gas Lighting* has been kept up during the year.

The Treasurer's report which is appended, shows the total amount of subscriptions to date, the available income and expenses for the year, a summary of the cash account and the statement of the amount of the surplus fund and the securities in which it has been invested.

The Surplus Fund, now amounting to $20,599.04, is made up of a contribution of $2,000.00, of subscriptions paid in advance of the time when they are due, of unexpended balances, of interest received on investments, and of a portion of the profit on the publication of "The Catechism of Central Station Gas Engineering in the United States."

Respectfully submitted,

TRUSTEES GAS EDUCATIONAL FUND.

WALTON CLARK, *Chairman,*
ALFRED E. FORSTALL, *Secretary.*

SECRETARY'S REPORT, SEPT. 30th, 1915.

	Section of 1915	Section of 1916	Section of 1917	Section of 1918	Total
Members enrolled Oct. 1, 1914	21	18	63		102
Entered class Jan. 1, 1915....				28	28
Additions to Class since Jan. 1, 1915				23	23
Reinstated since Oct. 1, 1914				2	2
	21	18	63	53	155
Resigned since Oct. 1, 1914..		1	5	1	7
Dropped for non-receipt of answers since Oct. 1, 1914..	1	2	23	25	51
Finished course since Oct. 1, 1914......................	20				20
	21	3	28	26	78
Total enrollment Sept. 30, 1915......................		15	35	27	77

Applications on file for admission to class Jan. 1, 1916................2

NAMES OF STUDENTS WHO COMPLETED THE THREE YEARS' COURSE WITH SECTION OF 1915.

Walter A. Badger, Portsmouth, N. H.
L. E. Binns, Chicago, Ill.
Wm. B. Carter, Catonsville, Md.
John F. Cassell, Baltimore, Md.
P. S. Dickey, Jr., Beloit, Wis.
Roy M. Godwin, Germantown, Pa.
Seth M. Hanson, Portsmouth, N. H.
Daniel L. Hill, Toronto, Canada.
Charles A. Johnson, Denver, Col.
Charles C. Jones, Philadelphia, Pa.
Wm. H. Kay, New Haven, Conn.
Charles C. Krausse, Baltimore, Md.
George S. Lees, New Haven, Conn.
Herman W. Mitchell, Rome, N. Y.
C. A. Penney, Colorado Springs, Col.
Alfred A. Post, Philadelphia, Pa.
Harold M. Rhoderick, Bayonne, N. J.
R. B. Richardson, Decatur, Ill.
Carle F. Sucher, New Haven, Conn.
John H. Viereg, St. Paul, Minn.

REPORT OF ALEXANDER C. HUMPHREYS, TREASURER, FOR FISCAL YEAR ENDING SEPT. 30th, 1915.

Condition of Subscriptions.

		For Year 1914-1915
Total subscriptions for third five-year period holding over	$ 1,408.33	$ 648.33
Total new subscriptions for fourth five-year period, Sept. 30, 1914	17,800.00	3,550.00
Total subscriptions received since that date	875.00	185.00
	$20,083.33	$4,383.33
Received from subscribers since Sept. 30, 1914	$ 4,269.00	
Payments not applicable to year	1,749.00	
Total paid in by subscribers since Sept. 30, 1914, and available for year	$ 2,520.00	
Paid in previous to current year on account of 1914-1915 installments	1,813.33	
Total paid in by subscribers available for this year	$ 4,333.33	
Still to be paid for this year	50.00	
Total amount available for year		$4,383.33

Statement of Income and Expense.

Total amount available for year		$4,383.33

Expenses.

Secretary's salary	$ 2,750.00	
Clerical help	250.00	
Office rent	300.00	
Printing, stationery, postage, etc.	601.00	
Cuts for illustrating answers	6.95	
Periodicals and binding	19.23	
Fire insurance on books	14.85	
Total expenses for year		3,942.03
Balance		$ 441.30
Depreciation on furniture		10.00
Total balance on year's operation		$ 431.30

Cash Account.

Received from subscribers since Sept. 30, 1914	$ 4,269.00	
Interest on securities owned as scheduled under heading "Surplus Fund"	885.00	
Interest on deposits in bank	81.58	
Received for copies "Catechism of Central Station Gas Engineering in the United States," including carrying charges	386.95	
Total receipts for year	$ 5,622.53	
Cash balance from last year	3,792.77	
Total to account for		$9,415.30
Expenses for year paid	$ 3,942.03	
" " previous year paid	97.63	
" publication of Catechism	.67	
Total paid out		4,040.33
Balance		$5,374.97
Balance in Columbia Trust Co., as per statement	$ 538.85	
Balance in Guaranty Trust Co., as per statement, less checks unpaid	4,836.12	
		$5,374.97

Publication Account.

Total receipts to Sept. 30, 1914	$ 5,963.40	
Received for copies of "Catechism of Central Station Gas Engineering," including carrying charges, since Sept. 30, 1914	386.95	
Total receipts to date	$ 6,350.35	
Due for books delivered but not paid for	13.15	
		$6,363.50
Total expenses to Sept. 30, 1914	$ 3,275.58	
Expenses since Sept. 30, 1914:		
Postage and expressage	.67	
Total expenses to date		3,276.25
Balance		$3,087.25

Of this amount $1,300 was transferred to Surplus Fund July 26, 1912, and $900 on Jan. 8, 1914.

Surplus Fund and Investment.

Amount paid in by subscribers in advance	$ 2,965.00	
Amount paid in by subscribers to Surplus Fund	2,000.00	
Net amount of unexpended balances previously reported	5,399.65	
Unexpended balance 1913-1914	768.02	
Interest on bonds to date	6,392.22	
Interest on deposits in bank to date	874.15	
Transferred from Publication Account	2,200.00	
		$20,599.04

Already Invested.

$2,000 Binghamton Gas Works, 1st Mortgage 5% Bonds	$ 1,930.00	
$1,500 Atchison, Topeka & Santa Fe R. R. General Mortgage 4% Bonds	1,513.75	
$2,000 Omaha Gas Co. 1st Mortgage 5% Bonds	2,000.00	
$1,500 New Gas Light Co. of Janesville, 1st Mortgage 5% Bonds (guaranteed by the United Gas Improvement Co.)	1,500.00	
$5,000 Syracuse Light & Power Co., Collateral Trust Sinking Fund 5% Bonds	3,831.25	
$2,000 Welsbach Company 5% Collateral Trust Mortgage Bonds	1,826.94	
$2,000 Detroit and Suburban Gas Company 1st Mortgage 5% Bonds	1,777.50	
$1,000 San Antonio Traction Co. 5% Bonds $1,000 San Antonio Gas & Elec. Co. 5% Bonds	1,995.00	
Furniture	90.03	
Balance		16,464.47
		$ 4,134.57

NEW YORK, Nov. 3, 1915.

The undersigned has this day examined the books and accounts of Alexander C. Humphreys, Treasurer, for the year ending September 30, 1915, and has found the same to be correct, and the above balance of $5,374.97 to be in bank.

C. N. JELLIFFE,
Auditor.

THE PRESIDENT: I will now call for the report of the Nominating Committee.

REPORT OF THE NOMINATING COMMITTEEE

The Committee appointed to nominate officers for the American Gas Institute for the ensuing year begs leave to submit the following nominations:

For President:
    William E. McKay, Boston, Mass.
For Vice-Presidents,
  Manufacturing Section:
    Herman Russell, Rochester, N. Y.
  Distribution Section:
    Jacob D. von Maur, St. Louis, Mo.
  Chemical Section:
    Dr. Arthur H. Elliott, New York, N. Y.
  Illumination Section:
    Charles O. Bond, Philadelphia, Pa.
  Accounting Section:
    John P. Crowley, St. Paul, Minn.
For Secretary and Treasurer:
    Geo. G. Ramsdell, New York, N. Y.
For Directors:
  (For full term.)
    Dana D. Barnum, Worcester, Mass.
    R. B. Brown, Milwaukee, Wis.
    Charles M. Cohn, Baltimore, Md.
    George B. Cortelyou, New York, N. Y.
    Robert B. Harper, Chicago, Ill.
  (For unexpired term.)
    Robert W. Bush, Brooklyn, N. Y.

ALBERT M. BARNES, *Chairman*,
H. C. ABELL,
RUFUS C. DAWES,
S. E. DEFRESE,
ROLLIN NORRIS.

The President: You have heard the report of your Nominating Committee, and if there are no further nominations, I will declare the nominations closed.

Dr. A. H. Elliott (New York): I move that the Secretary be empowered to cast one ballot for the election of the officers whose names have been presented by the Nominating Committee.

(Motion seconded.)

The President: Are there any remarks? It has been moved and seconded that the Secretary be empowered to cast one ballot for the election of the candidates as named.

All in favor say aye; contrary minded, no.

It is carried.

The Secretary: Mr. President, I have cast a ballot for the names as read.

The President: The Secretary, having cast a ballot for the names of the nominees presented by the Nominating Committee, I now declare the gentlemen elected to the respective offices for the ensuing year. I am quite sure you will be pleased to hear now from Mr. Bond. Mr. Keppelmann, will you conduct Mr. Bond to the platform?

(Mr. Keppelmann escorts Mr. Bond to the platform.)

The President: I want to introduce to you Charles O. Bond, who has been elected Vice-President of the Illumination Section.

Mr. C. O. Bond (Philadelphia): I am sure there is no more auspicious occasion on which to be elected as the Vice-President for the Illumination Section than on this visit to the San Francisco Exposition where we may witness the possibilities of illumination when the right man directs it. I only hope that what we see in lighting at the Exposition grounds will make such an impression as to send us home minded to better all illumination for which we are responsible.

I have felt that lighting is a neglected phase of our business. We have been content to put in fixtures on the strength of their own appearance, rather than on what they accomplish in illumination, and simply to supply gas and fixtures, is not to supply good lighting. As an exponent of that idea, if I have your support during the coming year, I hope we shall be able to show at least some improvement. (Applause.)

THE PRESIDENT: Will Mr. Harry Strange please conduct Dr. A. H. Elliott to the platform. Dr. Elliott will be in charge of the Chemical Section. Doctor Elliott, gentlemen.

DR. A. H. ELLIOTT (New York): Mr. President and gentlemen: It is a great honor to come across this continent and see such warm hearts and so many wonderful things in the development of gas. It is certainly something which I am proud to see.

I was one of those who began as a water-gas man. I do not want you to forget the chemist. I am essentially a chemist, but under the education of Mr. W. H. Bradley, I have been forced to become an engineer.

Now, do not forget that the chemical department is not to be neglected. Chemistry is coming to its own. It is destructive distillation and utilization of its products. If I can assist in the development of that idea among the members of the American Gas Institute, I shall be highly honored in this office.

THE PRESIDENT: I notice, among the members, a gentleman who has a smile which seems to have some of California's sunshine mixed in it. Mr. Robert B. Harper, of Chicago, one of the new Directors is present with us. Will Mr. McBride conduct Mr. Harper to the platform?

(Mr. McBride escorts Mr. Robert B. Harper to the platform.)

THE PRESIDENT: Gentlemen, Mr. Robert B. Harper, of Chicago.

MR. R. B. HARPER (Chicago): Gentlemen, I assure you I appreciate the California sunshine and also the honor which has been conferred upon me. I assure you I will do all I can to aid the Institute in the coming year.

MR. G. I. VINCENT (Des Moines): If it is in order, Mr.

President, I move that the Secretary be instructed to telegraph to Mr. McKay, apprising him of his election.

THE PRESIDENT: That is entirely in order.

THE SECRETARY: I would like to add to that motion, that we send a telegram of like character to Mr. Frederic Egner, advising him of his election to Life Membership.

MR. VINCENT: I accept the amendment with pleasure.

(Motion seconded, stated and carried.)

(For convenience of reference, insertion is made here of the answers to the above-mentioned telegrams, these answers having been read at a session of the Gas Congress after the adjournment of the Institute.)

THE SECRETARY: Mr. President, I have received the following telegram in response to one sent by me, announcing the election of Capt. William E. McKay; I also have one in acknowledgment of the message sent by Mr. Jones to Capt. McKay, and one from Mr. Frederic Egner, whom we elected a Life Member.

"GEO. G. RAMSDELL,
Palace Hotel, San Francisco, Cal.

Thank you very much for your telegram. I deeply appreciate the high honor of election to the Presidency of the American Gas Institute, and pledge my best service in its interests. WILLIAM E. MCKAY."

(Applause.)

This telegram is in reply to one sent by Mr. Jones:

"E. C. JONES, President,
American Gas Institute,
San Francisco, Cal.

My profound thanks for your kind telegram and good wishes. I greatly appreciate your assurance of support, and solicit the generous assistance of every member of the Institute. I deeply regret my involuntary absence from this meeting of the Institute, for which I hope the fullest measure of success. WILLIAM E. MCKAY."

(Applause.)

From Frederick Egner, whom we elected a Life Member:

"Geo. G. Ramsdell, Secretary,
American Gas Institute,
Palace Hotel, San Francisco, Cal.

Your telegram received, and I accept the honor with deep emotion and heartfelt thanks to all. Since the first instant (September) I have made two almost successful steps at eternity, and am still in the doctor's care, but your kindly act will, I think, help make me well again.

Sincerely always,
Frederick Egner."

(Applause.)

The President: We will now continue with the reports of the various committees. Vice-President Forstall will now take the Chair.

Chairman Forstall (Philadelphia): The first is the report of the Committee on Public Relations.

(Except where otherwise indicated, the reports that follows were merely read by title.)

REPORT OF THE COMMITTEE ON PUBLIC RELATIONS.

Your Committee on Public Relations begs to submit the following report on the work for the year:

During the past twelve months the Public Relations Committee has carried on, to a large extent, the work that originated with it in the past two years. Its program has been a constructive one, in that it has taken up such matters as have been referred to it by the Board of Directors and individual members of the Institute.

New subcommittees have been created to handle the questions coming within the jurisdiction of the Committee. The members of these subcommittees have devoted much time and expense to looking after the subjects assigned to them, and the results obtained have been so favorable to the interests of the industry and public as to justify the attention each individual has given to his work, and the Committee thanks each and all for the interest shown in this work of the Institute.

The Public Utility Commissions of several of the States have, during the past year, issued rules and regulations covering the quality and service of gas, and it is evident, from the work that has been done in the past in conferring with the members of these Commissions and their engineers, that certain facts and principles advocated by your Committee have been recognized and adopted in framing these regulations.

Your Committee has had representatives present at many of the hearings and has been ably assisted by several engineers and operators—all members of the Institute—who have voluntarily offered their time and assistance in appearing at these many hearings; the most important of which were held at Washington, D. C., Baltimore, Md., Hartford, Conn., Trenton, N. J., and Albany, N. Y.

In January your Committee received a communication from the Public Service Corporation of New Jersey, asking for assistance in presenting arguments to the Public Utilities Commission of New Jersey, protesting against the establishing of a 22 candle-power standard for the supply of gas in Trenton, N. J. Hearings were held before the Commission on January 5th and 19th, at which times evidence was introduced by all parties present, including the Bureau of Standards' representative, to show that the prevailing standard of 600 B. t. u. for all gas supplied in the State was a satisfactory requirement; and a return to an illuminating standard of 22 candle-power would be uneconomical and detrimental to the best service.

No order to return to the illuminating standard has been issued by the Commission.

During the month of January your Committee received an invitation to have a representative present at a public hearing before the Public Utilities Commission of the State of Connecticut. A representative of the Committee attended this hearing, at which time tentative rules issued by the Commission were generally discussed and criticised by the officials of the gas, electric light and water companies of the State.

This hearing was followed by a further conference, and in June, by a second formal hearing, the result of which was presented, and the final order issued by the Commission on June 30th, taking effect August 1, 1915.

In this order, the quality requirement of gas supplied throughout the State is for a total heating value of 575 B. t. u. monthly average, with a 530 B. t. u. minimum, and with no requirement for illuminating value. However, the utilities supplying gas must maintain a heating value equal to that supplied during the past year. The other service requirements covering testing, inspection of meters, control and regulation of pressures, etc., were reasonable and satisfactory; in fact, these latter requirements have been so well standardized throughout the country by advisory and regulating bodies, that there is now practically no difference in opinion as to what is desirable and practicable.

On January 6, 7 and 8, a representative of the Public Relations Committee, assisted by Messrs. C. O. Bond and T. J. Litle, Jr. appeared before the Maryland Public Utilities Commission, to advise with the Commission and to protest against the adoption of certain regulations in the published tentative rules for gas service in Maryland, ordered by this Commission. The Commission, in an order issued July 1, 1915, specified the quality of gas to be supplied by the Baltimore Consolidated Gas Company to have a heating value of 645 B. t. u. and an illuminating value of 20.8 candle-power, the remainder of the State being covered by an order requiring 600 B. t. u. and no candle-power.

This order, as written, permitted the Baltimore Company to adopt a heating value of 600 B. t. u. with no candle-power requirement—the same as the remainder of the State—provided they made certain concessions. These concessions were granted and on January 1, 1916, the Baltimore Company will work to the standard of heating value only.

During the early part of the year, the Secretary of your Committee had considerable correspondence with the Grand Rapids Gas Light Company, in regard to the action taken by the municipality with a view to considering municipal ownership of the gas works in that city. The people of Grand Rapids, Mich., by popular vote in the spring, rejected the proposition for the city to purchase and operate the gas works property.

Your Committee had similar correspondence with the owners of the Kalamazoo Gas Light Company, and regrets to say that while the stand taken by the authorities was not as positive in action, the conclusions reached from the investigation were not as favorable to the company.

The authorities of these two municipalities retained the services of an English engineer to pass upon the value of these properties, and to make estimates for their future operation. The reports submitted by this engineer were based upon actual operating conditions, as shown by the reports of both companies for the past two years. He concluded that the municipal authorities in this country could operate as economically as the company owners. His English experience in this matter, however, led him astray. In valuing the properties upon which to base a return, he did not take into consideration the many factors of valuation that have been allowed by our Courts and Commissions, and, therefore, submitted returns lower than were justifiable. He did not seem to realize that a large part of the expense of American companies is devoted to giving service, as well as making gas, and that our properties in this country are operated upon the American plan, while in England, the operation is upon the European plan, in which the larger part of the service is covered by extra charges.

An invitation was received from the Accountants' Committee of the National Electric Light Association to confer with it and assist in formulating a set of principles in accordance with which overhead, or general expense might be distributed over departmental accounts; the idea being that the National Street Railway, Gas and Electric Associations would better appreciate the full significance of this subject by such a conference. The question is a live one and is engaging the attention of many companies, as well as the State Commissions.

The Chairman of the Public Relations Committee, at the recommendation of the Board of Directors, reappointed the Committee on Accounting of the previous year, to represent the Institute in this connection. A joint meeting with the Committee of the National Electric Light Association, was held on May 17th, at Baltimore, Md., but no definite action was taken. The Chairman of this Committee has reported "progress," and it is hoped that the Committee will be continued for further work in this connection.

On March 10th the Bureau of Standards issued the third edition of Circular No. 32 "Standards for Gas Service." While similar in many respects to the second edition, certain portions were rewritten so as to indicate that the suggestions made by our subcommittee, which conferred with the Bureau in the revision of this Circular, were favorably considered. Notable among the changes are those occurring under "Basis of Rating," page 17, and in the "Rules recommended for adoption by State Commissions," which were completely rewritten and revised. The summary of State rules included in this Circular has been brought up to date.

In this connection, it might be appropriate to quote from a letter received from Dr. Stratton, under date of January 19th:

> "After very careful consideration of the comments which your Committee submitted to us, together with letter of December 15th, we have revised the proofs of Circular No. 32 for the third edition. It is unnecessary to indicate herein the changes which have been made in each case, for under separate cover we are sending to each member of the Committee a copy of the revised proof that indicates the principal modifications which have been made. However, there are a few points, on which the changes may not make clear our attitude and a few other points where we did not make changes which are mentioned in the enclosed memorandum.
>
> "I wish to express to your Committee, at this time, our appreciation of the co-operation which you have given us."

This letter indicates the attitude of the Bureau, with regard to the efforts of the Institute to co-operate with it in its work.

The Secretary of the Committee is of the opinion that it would be well to call the attention of the members of the Institute to the publication of this third edition of Circular No. 32.

At the last annual meeting, the Manufacturing Section of the Institute recommended the adoption of the Metropolitan No. 2 burner as the official burner for measuring the illuminating value of manufactured gas, and the Institute referred this recommendation to the Board of Directors with authority from the Institute to adopt the recommendations for the Institute, if the Board, after thorough investigation, decided that it was for the best interests of the Institute. The Board of Directors brought this question to the attention of the Institute members, by publication in the January issue of the *News*.

At a later meeting, owing to the views expressed by Dr. Stratton, of the Bureau of Standards, and several others, it was thought expedient to hold the matter in abeyance.

Practically all the State Commissions, in issuing rules and regulations governing gas service, have omitted the illuminating value requirement, and as such action has the sanction of the Institute, it is thought advisable to make no recommendation at this time, regarding the adoption of a standard burner for the purpose of measuring candle-power.

During July, 1914, it was noted that the Imperial Gas Association of Japan had presented a report, adopting the heating value standard and recommending that the "net" heating value be adopted. Your Committee wrote to the Association, calling their attention to the fact that the adoption of the "net" heating value was ill-advised and recommending that the "gross" or "total" heating value be adopted instead.

In the early part of March, this year, a letter was received from Mr. Charles P. Cushman, to whom the original correspondence had been addressed, stating that the suggested change had been made. Quotation from Mr. Cushman's letter:

> "Last July, I received a letter from you, dated July 9th, relating to the action of the Imperial Gas Association (of Japan) in adopting a calorific standard as a measure of the quality of gas for Japanese cities.
>
> "I am not a member of the Imperial Association, because its proceedings are conducted in the Japanese language, which I do not understand. Therefore, your letter was forwarded to the President of the Association, with the request that it be referred to the proper officer or committee acting upon the subject discussed.
>
> "After this long delay, I am advised that the matter has been taken up and acted upon, in accordance to your suggestion and that the 'gross' or 'total' heating value of the gas is to be considered as the means of expressing the calorific value, instead of the 'net' heating value, as at first decided upon.
>
> "The Association is indebted to you for the suggestion, and I certainly owe you an apology for my neglect in acknowledging your letter which was written as a kindness to us."

In February your Committee received a request from Dr. G. P. Girdwood, of Montreal, acting on behalf of the Royal Society of Canada, for information regarding the fatalities due to the use of carbureted water gas, and for information regarding any existing legislation limiting the percentage of carbureted water gas to be distributed. A reply was sent, citing the examinations conducted by various legislatures and State Commissions in this country on this subject, and stating arguments against the enactment of laws limiting the percentage of carbureted water gas in illuminating gas.

A subject of considerable importance recently brought to the attention of the officers of the Institute, has been an agitation for the compulsory installation on the head of the gas service of some form of shut-off valve, to operate either automatically, or manually from the outside of the building, for the purpose of shutting off the gas supply in case of fire or accident. This agitation has been the cause of the enactment of certain laws and ordinances, mostly municipal, providing for the installation of such devices, and more recently, some of the fire insurance rate-making bodies have considered the advisability of an increase in rates where such devices are not installed.

The tendency, on the part of those interested in the manufacture or sale of these devices, has been to urge the compulsory installation of some such device by the consumer.

The adoption of such laws, however, compelling the installation of such shut-off valve, the merits of which have neither been proved nor recognized, would, undoubtedly, place an unnecessary hardship upon both gas company and consumer and would not be compensated for by the benefits received.

A Committee, representing the Institute, was appointed to study the question, in order to be in a position to furnish information to gas companies, or to confer with State and local authorities, or fire underwriters' associations when the opportunity arose. Much work has already been done by this Committee, and in a number of cases their efforts have been fruitful in having the interests of the consumer and the company taken care of.

It is strongly urged that our members who are desirous of obtaining information concerning what has been done along these lines, or who may know of any proposed action about to be taken, communicate with the Chairman of this special Committee, which has been made a subcommittee of the Committee on Installation Regulation and Safety Code.

A communication was received from the Bureau of Standards, concerning an investigation of safety in the utilization of gas. This matter was referred to the Technical Committee, which Committee appointed Mr. W. J. Serrill, Chairman of the Committee on Utilization of Gas Fuel Appliances, and Mr. J. B. Klumpp, Secretary of your Committee, to join with Mr. O. H. Fogg, of the National Commercial Gas Association, and Mr. S. S. Wyer, of the National Gas Association of America, in conferring with the Bureau on this subject.

This Committee has had a conference with the Bureau's representative, and it is recommended that they continue to assist the Bureau in the preparation of this safety code. This Committee will, however, be a subcommittee—reporting to the Committee on Installation Regulation and Safety Code.

In view of the fact that the duties of several of our subcommittees were similar, to a certain extent, and somewhat overlapped, it was decided to consolidate them, forming one general committee—the Committee on Installation Regulation and Safety Code. The personnel of this Committee is as follows:

Mr. W. R. Addicks (Chairman), Mr. G. S. Barrows, Mr. C. M. Cohn, Mr. E. G. Cowdery, Mr. J. B. Douglas, Mr. O. H. Fogg, Mr. J. B. Klumpp, Mr. F. E. Luther, Mr. C. E. Reinicker, Mr. W. J. Serrill, Mr. J. D. von Maur, and Mr. W. A. Wood.

In organizing this Committee, the personnel of the various Committees that were looking after these matters was, for the larger part, continued the same, so that the work, where unfinished, could be carried on by the men who were already interested. The subcommittees of this general Committee are now representing the Institute in conferences in the preparation of precautionary measures or safety codes, with the Bureau of Standards, National Fire Protection Association, and various Municipal, State and Federal authorities, and will also continue the work undertaken in the past by the very able Committee on Accident Prevention, that has, heretofore, been reporting to the Technical Committee. With this arrangement, it is believed that the work of the subcommittees will be aided by the experience of the entire Committee, and considerable benefit should be derived from the ability to call on any member of the main Committee for suggestions and advice on matters on which they are informed.

Your Committee calls the attention of the Institute to the annotated publication of orders and decisions handed down by the Commissions and Courts, concerning the cases involved in public utility questions; by the Lawyers Co-operative Publishing Company, of Rochester, N. Y. These publications are issued semi-monthly, in pamphlet form, and later in bound volumes. It is recommended that members who are at all interested, subscribe to this work, as it is being conducted on a substantial financial basis, which insures a continuance of these publications in a thorough and comprehensive manner.

A communication was received by the Secretary of the Institute, asking for the co-operation of the American Gas Institute with the National Commercial Gas Association, assisting the United States Bureau of Standards in the preparation of statistics pertaining to the gas industry, and on the approval of the Board of Directors, the Chairman of the Public Relations Committee appointed by such a subcommittee.

The work of many of the subcommittees, reporting to the Public Relations Committee, is progressive and will not be completed at the end of our fiscal year, and it is recommended that these Committees be continued to complete their labors.

Respectfully submitted,

GEO. B. CORTELYOU, *Chairman,*
SAMUEL T. BODINE,
JOHN A. BRITTON,
HENRY L. DOHERTY,
J. L RICHARDS,
MORRIS W. STROUD,
J. B. KLUMPP, *Secretary.*

(On motion the report was adopted.)

CHAIRMAN FORSTALL: I will ask the Secretary to read the report of the Technical Committee as it describes some very important work done this year:

REPORT OF THE TECHNICAL COMMITTEE.

September 10, 1915.

To the Board of Directors:

Your Technical Committee reports as follows:

MEETINGS.

Your Committee has held five meetings during the year. Since the Committee has been complete, meetings have been held practically every month. We feel that this procedure should be adhered to.

WORK.

The merging of the meeting of the Gas Institute with that of the Gas Congress, and the turning over of the preparation of papers to the Gas Congress, has eliminated from the work of the Technical Committee this year the necessity of securing authors for papers, and has left the Committee free to devote its entire attention to the matter of committtee reports. The work of the committees is constantly increasing in importance, and the Technical Committee this year has given a great deal of thought and study to the plan and scope of the work of the various subcommittees. The work of many of the committees is now of such a character that it must of necessity be continued from year to year. The working out of some plan for insuring the continuity of this work, and the elimination of the delay heretofore present in the appointment of the members of the various committees, has occupied a good part of the time of the Technical Committee, and the plan as finally outlined, is presented for your consideration in a subsequent part of this report.

SUBCOMMITTEES.

As organized at present, the following Subcommittees are reporting to the Technical Committee: Accident Prevention, Bureau of Information, Carbonization, Chemical Tests, Classification of Gas Engineering, Gas Housepiping, Gas Lighting, Gas Works Auxiliaries, Meter Connections, Physical Tests, Pipe Joints, Pipe Standards, Refractory Materials, Supplying Large Buildings With Gas, Utilization of Gas Fuel Appliances, and the Committee on International Uniform System of Pipe Threads. In addition, the Institute's Representatives on the Joint National Committte on Electrolysis also report to the Technical Committee. Of these committees, those on Chemical Tests, Classification of Gas Engineering, Gas Works Auxiliaries, Gas Housepiping, Meter Connections, Physical Tests and Pipe Joints are new committees appointed this year in accordance with the recommendations of last year's Technical Committee. Reports from all of these committees, with the exception of the Committee on Physical Tests, have been received and are presented to the Institute. Your Technical Committee has carefully gone over these reports, and believes that the Institute is to be congratulated on the very fine work of its committees. Many of the reports are in the nature of progress reports only, and all of them show the great amount of time and study which has been devoted to their preparation.

ACCIDENT PREVENTION COMMITTEE.

This Committee has been doing very excellent work, and the work should be continued. During the year, certain problems have come up in connection with the Bureau of Standards, and the work generally is of such a nature that we feel this Committee should more properly come under the jurisdiction of the Public Relations Committee, and would so recommend.

BUREAU OF INFORMATION.

There has been a noticeable lack of interest on the part of the Institute membership in the work of this Bureau, as evidenced in the report submitted by the Bureau. Your Technical Committee is inclined to concur with Recommendation No. 4 as contained in this report, and believes that the work of the Bureau should partake more of the nature of a Question Box, and that the aim of the Question Box should be one of general education to the entire Institute membership rather than of particular information for the individual who may submit the question. We believe that this work should be carried on by a single chairman or secretary of the Question Box and that, eventually, if not at present, this individual should be hired and paid by the Institute for this work, the Institute *News* to be the medium used for distributing this information. Therefore, we recommend that the Bureau of Information as at present organized be discontinued.

CARBONIZATION.

The report of this committee shows that it has this year departed somewhat from the work of the previous Committees. We believe this is a decided improvement, and recommend that the scope of the work of this Committee be broadened, and that the title be changed from that of "Carbonization" to "By-Products and Carbonization Committee."

CHEMICAL TESTS.

Working with the report on the Chemical Handbook submitted by Mr. W. H. Fulweiler at last year's Chemical Session as a basis, this year's Committee has elaborated and enlarged materially on this work. It has in preparation and well under way toward completion a "Gas Chemist's Handbook." When completed, this promises to be a very valuable addition to the Institute literature.

CLASSIFICATION OF GAS ENGINEERING.

This Committee comes as a natural result of Mr. Knauss' paper of last year. The scope of the work has been very much broadened by securing the co-operation of other technical societies, and the work when completed, promises to be of great value not only to the gas fraternity, but to other engineering bodies as well.

GAS HOUSEPIPING.

The formation of this Committee comes as the result of a recommendation of last year's Technical Committee. Its work has consisted in the preparation of standard specifications for housepiping, with a view toward having them published in book form and distributed generally for the use of architects, plumbers, Public Service Commissions, Common Councils, and other legislative bodies. This year's Committee has made a most excellent start on this work.

GAS LIGHTING.

It was thought best to change the name of this Committee from "Illumination" to that of "Gas Lighting." The scope of the work of this Committee is well outlined in the report.

GAS WORKS AUXILIARIES.

This Committee comes as a somewhat natural outgrowth from last year's Committee on the "Measurement of Gas in

Large Volumes." The title broadens the scope of the work of the Committee, and leaves it free to study any of the many problems constantly arising with various apparatus used in connection with gas manufacture.

INTERNATIONAL UNIFORM SYSTEM OF PIPE THREADS.

This Committee has, of course, not been able to accomplish anything this year, and probably will not for a number of years, and we feel that it should be discontinued until the time becomes more propitious.

METER CONNECTIONS.

The creation of this committee was the result of a recommendation of last year's Technical Committee. The Committee has made a most excellent start, and the work carried to completion, promises to fill a long felt want.

PHYSICAL TESTS.

This committee is also the result of a recommendation of last year's Technical Committee. We believe that the work should be continued.

PIPE JOINTS.

This is a new Committee, appointed this year, on the recommendation of last year's Technical Committee. The subject is one of the most important with which the Institute has to deal at present, and the lack of any standard practice, leaves a great deal of work to be accomplished by this Committee. The report as submitted shows very clearly the many problems to be solved, and indicates clearly the necessity of continuing the work.

PIPE STANDARDS.

The work of this Committee was in the main completed last year, but we feel that it should be continued from year to year in order to take up any new problems which may arise, and to make such alterations in the present standards as seem necessary from time to time.

REFRACTORY MATERIALS.

This Committee was continued from last year. The nature of its work is such that it must of necessity be a standing committee. The report as submitted this year will, we believe, be of great interest to all members of the Institute, and represents a very happy combination of the separate interests of the user, builder and maker. The work of the Bureau of Standards in connection with this Committee cannot be too highly complimented, and shows very clearly the very great help which such a government research and testing laboratory may be to the technical industries.

SUPPLYING LARGE BUILDINGS WITH GAS.

This committee is continued from last year. The work this year has consisted in the working out of material to be used in the preparation of a book for distribution to gas companies, architects, plumbers, etc., somewhat along the lines of the book to be published by the Housepiping Committee.

UTILIZATION OF GAS FUEL APPLIANCES.

This Committee is also a continued committee from last year. The work of this Committee consists in the continued study of the many problems arising out of the utilization of gas, and the study of the various gas appliances. The Technical Committee believes that gas engineers have not given sufficient study and attention to the problem of the more efficient use of gas as a heating medium. Types of stoves and industrial appliances now in use are, at best, very wasteful and inefficient. Continued inroads of electricity in this field, resulting from a very much greater efficiency of electrical apparatus and the lowering of electrical rates, can no longer be ignored by the gas men. The time has arrived when, if we are to retain and increase the gas heating business, we must pay a great deal more attention to a study of the efficient designing of apparatus for this work. Heretofore, the great difference in price on a B. t. u. basis existing between gas and electricity has made the question of the efficiency of gas apparatus of little importance. If we are to continue to command this field, we must so design our apparatus as to recover a large percentage of the heat which we are now permitting to go to waste. The Technical Committee feels that the work of the Committee on the Utilization of Gas Fuel Appliances should next year be largely devoted to the study and investigation of these problems.

In view of the fact that the reports of many of the Committees are simply reports of progress, and because of the fact that the work of many of the Committees is of such a nature that it should be continued from year to year, we recommend that the work of the Committee as outlined above be continued.

RECOMMENDATIONS.

Appointment of Committees and Continuity of Work.

The work of this year's Technical Committee and that of the various subcommittees this year has been greatly hampered by the delay incident to the organization of these various committees and the failure to provide for the continuity of the work from year to year. Under the present method of procedure in appointing these Committees, delay is inevitable. After each annual meeting the practice has been to select the Technical Committee. By correspondence, this often has taken as long as three or four months. The Technical Committee then decides on what various subcommittees to appoint to properly handle the year's work, and then selects chairmen for these different committees. After the chairmen are selected, the different members of the committees are chosen, and no work is possible until the committees are complete. With the number of committees now operating, this plan is impracticable. After considerable study of this problem, and as a means of doing away with this delay and insuring the continuity of the work of the committees, the Technical Committee recommends that the following plan be tried out, and later, if found satisfactory, to be incorporated in the By-Laws.

First.—That the Technical Committee for the year be appointed by the incoming President before the close of the annual meeting, and that the man selected as Chairman of the Technical Committee should preferably be a member of the preceding year's committee.

Second.—The Committees should be known as "Continuing" and "Temporary," it being understood that a "Temporary" Committee is one whose work is completed during the year, and a "Continuing" Committee, one whose work extends from year to year.

Third.—At least a majority of each "Continuing" Committee should be reappointed.

Fourth.—The retiring Chairman of each "Continuing" Committee should reach an understanding with the members of his Committee before the annual meeting, regarding the personnel of the majority to be continued, and should so report to the Chairman of that year's Technical Committee.

Fifth.—The Chairman of the retiring Technical Committee shall, prior to the annual meeting, receive from the Chairman of each "Continuing" Committee the personnel of the majority of members of his committee who are recommended for continued service, and he shall report these names and committees to the Chairman of the incoming Technical Committee before the close of the annual meeting.

The plan, as outlined above, means that every member accepting a committee appointment should be prepared to serve at least two years.

Co-operation of Affiliated Associations.

During the year, several of the associations affiliated with the Institute have asked how they might help in the Institute work. In connection with the Illinois Gas Association, advantage was taken of this offer by the Meter Connections Committee. This Committee had been asked to give special study to the problem of "meter shelves," and felt that the time was too short and the problem too great for it to undertake this year. At the suggestion of the Technical Committee, it delegated this phase of work to the Illinois Association, with the result that the Illinois Association has appointed a committee to take up the subject of "meter shelves" and to work in connection with the committee of the Institute.

Your Technical Committee feels that this work should be extended. Each year there are problems arising in connection with the committee work which could very well be submitted to these various associations for their solution. The committee appointed by the affiliated association to study this problem would work under the direction of the Institute committee, and report the result of its findings to this Committee, who would in turn review the work and submit it as part of its report to the Technical Committee. In this way we feel that there will be a closer relation between the Institute and the affiliated associations, and a great deal more work acomplished each year.

PUBLICITY.

The Technical Committee has this year from time to time requested the various subcommittees to give to the columns of the *News* a brief report of the various meetings. We feel that this practice should be continued and enlarged upon, and only in this way can the members of the Institute at large be acquainted with the work of the various committees during the year, and the progress which is being made. The success of the work of the Committee largely depends upon the interest and co-operation of the Institute members. We believe that the publication of these meeting reports, from time to time during the year, will help greatly in securing this interest.

Your Technical Committee is proud of the work which the various subcommittees have accomplished this year, and we take this occasion to express our gratitude for the interest and zeal manifested by the different committee members.

H. RUSSELL, *Chairman*, H. W. PECK,
O. B. EVANS, C. C. TUTWILER,
D. E. KEPPELMANN, G. I. VINCENT.

Chairman Forstall: The report of the Technical Committee is before you, and a motion to approve it or any discussion upon it is in order.

(Motion made, seconded and carried to adopt the report as presented.)

Chairman Forstall: Next is the report of the Committee on Beal Medal.

The Secretary: I have received the report by telegram from Mr. Gartley, and it reads as follows:

REPORT OF THE COMMITTEE ON BEAL MEDAL.

The Committee has awarded the Beal Medal for the year 1914 to Mr. F. W. Steere, for his paper on "An Electrical Process for Detarring Gas."

W. H. Gartley, *Chairman*,
V. F. Dewey,
W. E. McKay.

REPORT OF THE COMMITTEE ON ARRANGEMENTS.

Chairman Forstall: The program calls for a report of the Committee on Arrangements. The Committee on Arrangements has been talking to us ever since we have come to San Francisco, in a most effective manner. Everyone can see their work, and their report is the arrangements which they have made for our comfort.

Chairman Forstall: The next is a report of the Committee on Accident Prevention. Mr. Douglas had hoped to come here, and I know he would have spent a few moments profitably in showing you the Committee's work. He has sent an accident prevention film, which if time allows, we wish to show to the Gas Congress. It will be well worth seeing.

REPORT OF THE COMMITTEE ON ACCIDENT PREVENTION.

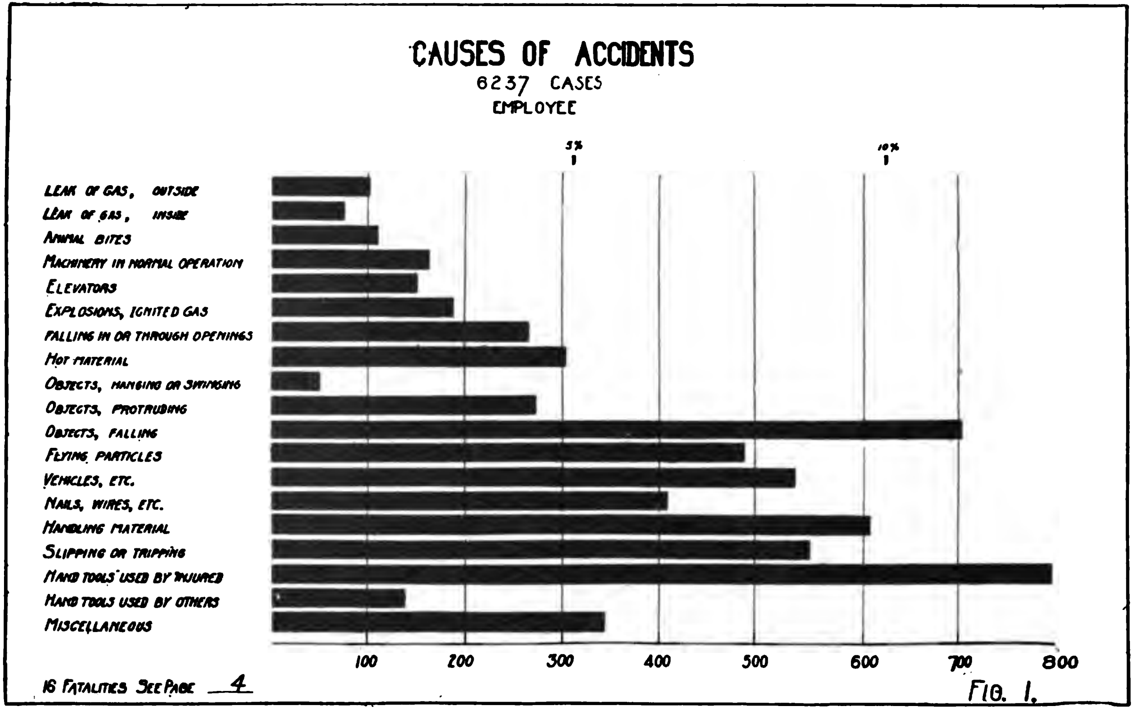
WORK OF COMMITTEE.

The Committee on Accident Prevention has been engaged in carrying on the work recommended by its predecessor in the report at the last annual meeting of the Institute.

It has been impracticable to hold frequent committee meetings with any degree of success because of the long distance for members to travel, and consequently, nearly all of the work has been carried on through correspondence.

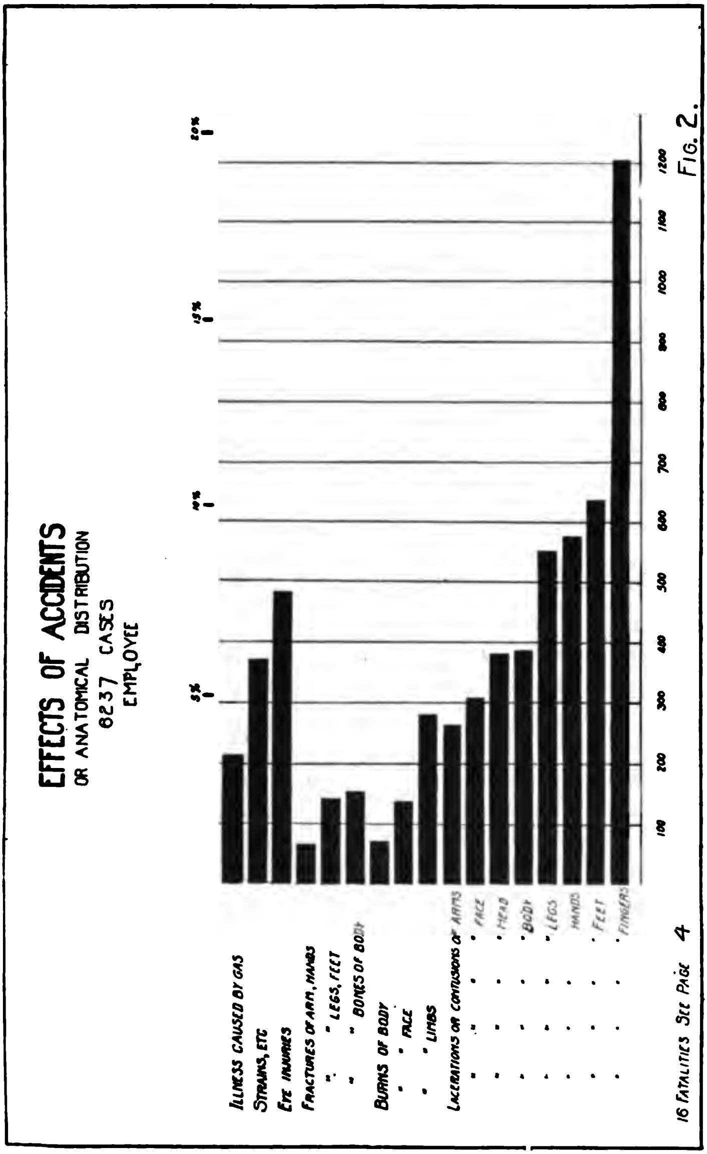
Last May supplies of accident report forms were sent to the various members of the Institute, informing them that the Committee expected to continue to make analyses of accident cases in order to secure the benefit of a greater "experience" from which to indicate the prevailing causes of accidents, and asking for reports dating from September, 1914, when the report of the preceding Committee was closed. The form calling for less information than it did last year, it was thought that the immediate response would be more gratifying. We, however, found it necessary to make a second request for information in July, and the combined results showed a total for the year of 2,736 employees cases received from 82 companies distributed throughout 33 states. These reports, together with those analyzed in the report of the Committee on Accident Prevention last year, make a total of 6,237 employee cases received from 119 companies in 35 states, from which the following charts have been made.

Owing to the fact that in many instances the questions asked on the accident report form were unanswered, it has been decided to include only the cause and effect charts in this report.



16 FATALITIES SEE PAGE 4

FIG. 1.



EFFECTS OF ACCIDENTS
OR ANATOMICAL DISTRIBUTION
6237 CASES
EMPLOYEE

16 FATALITIES SEE PAGE 4

FIG. 2.

Included among the number of cases shown on these illustrations are 16 fatalities, due to the following causes.

a. Machinery in normal operation.
  1. Caught in pulley of coke conveyor.

b. Falling objects.
  2. Struck on head by falling piece of coal.

c. Vehicles, etc.
  3. Thrown by skidding motorcycle.
  4. Struck by street car.
  5. Struck by automobile while at work in ditch.

d. Hot objects and materials.
  6. Burned by hot tar.

e. Explosions, ignited gas, etc.
  7. Burned by gas escaping from generator door struck by fuel buggy.
  8. Burned by gas escaping from improperly clamped generator door.
  9. Burns following explosion of gas escaping from "revivification" machine.

f. Falling in or through openings.
  10. Falling from engine cylinder head.

g. Leak of gas, outside.
  11. Overcome by gas while tapping main.
  12. Same.
  13. Same

h. Elevators, etc.
  14. Falls down elevator shaft.
  15. Caught between elevator chain and pulley shaft.

i. Miscellaneous.
  16. Burned while extinguishing fire at tar still.

Of the 2,550 cases reporting on disability in the reports of this year, there were 1,423 cases that reported no disability following the accident; 1,127 cases reporting a total of 13,339 days, of which 198 cases resulted in disability of more than two weeks, the average time of these cases being 30½ days.

SAFETY ORGANIZATION.

It is a well known fact that many of the larger industrial plants of the country have reduced the number of preventable accidents almost to a minimum. These decreases are attributed to co-operation with safety departments in their efforts to prevent accidents.

Systematic safety work provides the greatest step towards the prevention of accidents. A varying difference in the size of member companies, however, makes it impossible to outline a safety organization that will meet every demand, but the following simple plan, a revision of the one recommended last year, should fulfill the requirements of the average gas company.

The safety organization should consist of a chairman, who should be the manager, superintendent or his assistant, a safety inspector, and three other employees appointed from the manufacturing, distribution and commercial departments by the chairman of the Committee. This Committee should meet at least once a month, when the work of the month should be gone over and discussed. Special meetings of the Committee should be called in the event of a serious accident or of one of peculiar interest. Items in the safety journals should also be reviewed, and the Committee should compile and issue such information and statistics as are applicable to the company and existing conditions, should pass upon articles, pictures, etc., for bulletin boards, should investigate and act upon such recommendations as have been submitted, and should devise ways and means to keep alive the interest of the employees to the importance of exercising care to prevent accidents. Interest is aroused through the aid of safety talks, lantern slides and motion pictures. First aid competitions, etc., are also very beneficial.

The safety inspector should be chosen from among the employees of the company and should be one who can devote a good part of his time to the work of looking after safety details. He should make thorough inspections of the plant periodically, noting all accidents hazards and hazardous working conditions. It should be his duty to pass upon the installation and maintenance of safeguards. When the cost of carrying out a recommendation exceeds a limit to be set by the Committee, the safety inspector should see that conditions are made safe, and wait for the following Committee meeting before taking action, except in cases of extremely dangerous hazards, when a special meeting of the Committee should be called to consider the matter.

The men appointed from the several departments should be chosen from the rank and file of the employees. Care should be taken in making these appointments, as the men chosen should be proficient in their own work, and should command the respect of their fellow employees. The duties of these men should be always to be on the alert to note and report accident and fire hazards, and to make weekly inspections of company work and property. All recommendations should be referred to the safety inspector, who should investigate the conditions reported and submit the result to the Committee. These men should meet with the safety inspector at such times as may be desired by him, when all new cases should be reviewed and new prevention work and ideas discussed.

When the size of the company will permit, it is thought advisable to form additional committees in each department.

The personnel of the employee members of the Committee should be changed from time to time in order that all suitable employees may eventually receive training in safety, and broaden their knowledge of the work.

It is suggested that all recommendations be made on printed blank forms arranged about as follows (size 8 by 11 inches). The disposition of the hazards may be noted thereon, and the recommendations filed as matters of record.

ACCIDENT HAZARD INSPECTION			
Location	Hazard	Recommendation	Remarks

RULES AND PRECAUTIONS.

The list of rules and precautions given in the report of the last Committee has been gone over constructively, many new measures being suggested, and in some cases, precautions suggested last year, have not been repeated. Some of the suggestions are taken from the Pennsylvania Safety Standards. In order to avoid any conflict in the committees' work, endeavor has been made to omit rules and precautions which might be classified as strictly operating matters.

Accidents.—Accidents involving personal injury should be reported at once to the person in charge of the work, who should see that the injured person receives immediate attention. In case of serious injury, the office should be notified by telephone or telegraph at once. Trivial accidents should be reported promptly. Employees should be instructed to report at once defects and conditions liable to cause accidents.

GENERAL PRECAUTIONS

Covers.—Pit, well and valve box covers when in or abutting passageways, should be flush with same.

Where covers are provided with handles, the covers should be so recessed that the handles will not protrude above the level of the cover when not in use.

All covers should be kept in place wherever possible, otherwise a guard should be placed around the exposed opening.

Electric Switches, Wires, etc.—Electric switches, circuit breakers, rheostats, etc., of 220 volts or more, should be enclosed and danger signs placed on the doors.

Close inspection should be made of all electric wiring with which persons might come in contact. Defective insulation should be repaired at once.

Portable electric lamps for use around machinery, etc., should be enclosed in substantial, insulated wire guards. The lamp sockets should be inspected for defects in insulation.

To avoid the danger of shock, inexperienced employees should not be permitted to repair switches, fuses, lights, etc.

All wiring should conform to the rules of the National Board of Fire Underwriters.

All electric wiring in or around gaseous atmospheres should be enclosed in a grounded metal conduit. Switches and switch boxes should be placed in a position free from danger of explosion caused by spark. Lamps should be enclosed in hermetically sealed globes.

Open ends of passageways in rear of switchboards should be closed. Grounded wire mesh screen doors are suggested.

Rubber mats should be placed on the floor in front and back of switchboards. They should extend the entire length of the switchboards.

Elevators.—Elevator shafts should be cased in and self-closing gates installed in front of openings to elevators on each floor level. The casing and gates should be high enough (say 7 feet) to prevent a person from extending head over gates into shaft. The casing and gates should extend to the floor level to prevent material from falling into shaft.

Counterweight shafts should be encased from their base to a height of at least 8 feet.

Toe guards should be provided at each floor level to prevent persons riding on elevator from getting feet caught between elevator platform and the floor or extensions into shaft.

Elevator platforms should have fence guards at sides and back. Top of elevator car should be covered with a heavy wire mesh guard to protect persons on platform from being struck by material falling into shaft.

A flooring or heavy wire mesh guard should be placed under sheaves and also under the machinery at the top of the elevator shaft.

Safety terminal stops should be placed on starting cable at upper and lower levels, and lock stops for each floor level should be installed.

There should be at least 3 feet clearance between under side of elevator platform and bottom of elevator pit when the elevator is at the lowest point. Landing posts in pit are advisable.

Elevator, cables, sheaves, etc., should be frequently inspected.

The space between the top of the elevator gate and the ceiling should be cased or covered with a meshed wire guard.

Elevator gates should be of the semi-automatic, self-closing and locking type, and it should be possible for the operator to open the gate only from the inside and when the elevator is at that floor level.

Where there is not sufficient room for self-closing gates at the foot of the shaft, swinging or sliding gates should be provided, and warning chains suspended from the bottom of the elevator platform.

Safety rubber stops should be placed between pairs of sliding elevator doors to prevent injury to operator's hands.

Floorings in front of elevator entrances should be of such material as will give secure footing.

Entrances.—Entrances to yards should be kept closed or guarded, and the public should be admitted only on permission from the proper authority. Children, especially, should be kept out of yards.

Floorings.—Loose and raised floor boards should be fastened in place; broken and splintered boards removed and protruding nail heads hammered down.

Where floors are slippery from oil or grease, they should be sanded and the cause of such condition removed as far as possible.

Coverings, such as linoleum, etc., should be kept in repair and securely fastened in place.

Floor openings should be equipped with risers or toe-boards to prevent material from falling on persons below.

Small holes in floors should be covered.

Gates, Doors.—Gates fronting on roadways or footways should be hung so as to swing in or slide. Periodical inspections should be made of hinges, tracks and carriers, to see that they are secure. Doors and swinging gates should be securely fastened in either open or closed position.

Gradual approach of ground level or roadway should be made to center posts and guide blocks of swinging or sliding gates, where same protrude above surrounding levels, to avoid tripping hazards.

Ladders.—Care should be exercised to see that ladders are of sufficient strength for the purpose used.

Straight ladders should be equipped with hooks and safety spurs or feet.

All ladders should be regularly inspected and kept in good repair. Ladders beyond repair should be destroyed at once.

Permanent ladders should be installed wherever possible for the use of oilers, etc.

Ladders to roofs should extend to a distance of 3 feet above roofs. Rungs should be omitted from the section above the roof. Platforms should be provided from ladder to roof when the distance between the ladder and the roof is 18 inches or more.

Stack or other long straight permanent ladders should be provided with cage guards.

The distance between the center of the rungs and any permanent object back of the ladder should be at least 8 inches. A clearance of 30 inches should be allowed between any obstruction and the front of the ladder. This does not apply to an enclosure of a ladder nor to a wall 20 inches or more in front of a ladder, which would give the protection of an enclosure.

Bracing, steps, etc., of step-ladders should be subjected to close inspection.

Treads or rungs of all ladders should be regularly spaced.

Loose Bricks, etc.—Loose bricks, cap-stones, etc., on chimneys, tops of walls, offsets or ledges, or over door and window openings, should be removed or rebedded. Cornices, gutters, rain-spouts and pipes should be frequently inspected. Roof slates should be inspected periodically and loose slates removed or made fast. Provision should be made to prevent snow-slides from roof. Icicles should be broken.

Loose boards and material should be removed from roofs.

Machinery, etc.—When it is impracticable, due to operating conditions, to stop machinery for oiling, it should be oiled through automatic oilers or from outside of guard rail.

Oiling should be done only by authorized and experienced persons, and in accordance with approved and safe practice. Ragged clothing should not be worn.

Set screws protruding from shaft collars, pulleys, etc., should be covered or replaced with countersunk set screws. Shaft ends extending beyond bearings or collars with keys or key slots, should be covered.

Horizontal shafts, less than 6 feet from the floor or platform level, including the dead ends of shafts, should be guarded or protected by a hand-railing, as provided for horizontal belts.

Vertical shafts should be encased or guarded to a height of 6 feet from floor or platform level.

Revolving shaft couplings should be cylindrical and the bolts preferably should not project beyond the periphery of the couplings. Where such conditions exist, a metal case guard should be used.

Flexible couplings should be substantially guarded in a manner to remove all hazards.

The operating mechanism of friction clutches should be completely guarded when exposed.

Change belts should not be laced with metal fasteners.

Where the bearings of loose pulleys are not self-oiling, and the clearance between the pulley and the bearing hanger on line shafting is 36 inches or less, the pully should be completely guarded on the side nearest the hanger and all keyways in the shaft between such pulleys and hangers should be encased or filled.

All parts of pulleys less than 7 feet above the floor or working platform level, should be guarded underneath, or protected by a railing as provided for horizontal belts.

Where the space between two pulleys or between a pulley and a hanger, is less than the width of the widest belt used, such space should be guarded so that the belt cannot get between the pulleys, or between the pulleys and the hangers. This can be done by a flange on the side of the pulley nearest the hanger or adjacent pulley.

On countershafts, the space between pulleys and the nearest hanger should not be less than the width of the belt used, unless such space is guarded.

All tooth, chain driven and sprocket driven gearing should be completely enclosed wherever possible, otherwise at least to the base of the teeth.

Vertical or inclined belts extending to within 6 feet of the floor or working platform level should be guarded. The following ways are suggested:

If the guard is placed less than 6 inches from the belt,—by an enclosure on all sides, with not over ½ inch between members and extending to a height of 6 feet above floor or working platform. If the guard is placed between 6 and 15 inches in clearance from the belt,—by an enclosure on all sides to a height of 6 feet, with not over 2 inches between members. A guard rail may be used if placed 15 inches horizontally from the belt.

Where belts pass through a floor, they should be encased to a height of 6 feet. If guard rails are used, they should allow

15 inches clearance from the belt, and toe-boards or risers should guard the floor opening.

If the upper part of a horizontal belt extending from the wall, floor or shafting, is less than 6 feet from the floor or working platform, the belt should be guarded on top and sides, or provided with a rail guard at least 15 inches, horizontally, from the edge of the belt.

Belts with the lower part 7 inches or less above the floor or working platform level, should be guarded on the sides and bottom.

Passage between the upper and lower parts of belt should be prohibited. The space traversed by such a belt should be completely barred against passage.

Guard-rails where mentioned should be of rigid construction, preferably of 1¼-inch pipe and should be 42 inches in height. An intermediate rail should be placed midway between top rail and floor level.

Toe-boards of wood or metal, 6 inches high, should be installed around the edges of floor openings, machinery pits, platforms, etc., where there is any danger to persons below due to falling objects.

Approved types of shifters should be provided for clutches and belts of all tight and loose pulleys.

Shifters and disengaging levers when suspended overhead should be arranged to hang vertically when the belt is on the loose pulley, or the clutch is disengaged.

Belt shifters should be automatically held so that the belt will not creep from the loose pulley to the tight pulley.

Emery or other abrading wheels should be guarded with safety hoods and eye shields, or if the eye shields are not practicable, goggles should be provided. The use of defective grinding wheels should be prohibited. Protruding ends of arbors should be guarded. Floor and bench grinding machines should be rigidly constructed and securely fastened to a suitable foundation. Grinding wheels should not be operated at a speed in excess of that which is recommended by the manufacturer, and should run true on the shaft.

Circular saws should be provided with hood guards and a spreader located at the rear of the saw. Saws should be guarded under the table to prevent possible contact. Band saws should have both wheels and the rear saw blade encased, and the exposed saw blade should be provided with a guard extending down to the guide block to prevent the operator from coming in contact with the saw. Flooring around dangerous machinery should be such as to give secure footing.

Oils.—Lubricating oils, paint oils, kerosene, alcohol, etc., should be stored in an oil house, preferably separated from the other buildings.

Gasoline should be stored underground.

Pentane should be kept in a cool place, preferably in a pipe or case underground.

No exposed flame should be allowed in or near an oil house or other place where oil is stored. Smoking also should be prohibited.

Lifting of filled barrels, drums, etc., should be done with tackle or some lifting device.

Gasoline cans and fillers should be of an approved safety type.

Passageways.—Overhead passageways should be of sufficient width (say 24 inches) to give ample footing, and should have hand-rails on one or both sides and risers or toe-boards. Tools or other obstructions should not be left on passageways. Provision should be made for head room.

Passageways should be kept well lighted.

Obstructions and depressions in passageways, paving, sidewalks, etc., should be eliminated.

Steam, water or other lines of pipe extending across passageways, should be placed below level of passageways, or raised high enough to give head clearance.

Stairways.—When a stairway is 4 feet or less in width, a hand-rail should be provided; when over 4 feet in width, a hand-rail should be placed on each side of the stairway. Handrails with an intermediate rail should be placed on open stairways. Stairways should be well lighted and should be kept free of obstruction. Provision should be made for head room.

Worn and slick metal treads should be roughened or replaced.

Guard-rails should be placed around floor openings to stairways; also toe pieces to prevent material falling on the stairways.

Bars or guard rails should be placed across all low window openings on stairways.

Long straight stairways should be avoided. Serial platforms should be installed. Landings should not be less than 12 feet apart, measured vertically.

The distance between treads of stairs should be equally spaced and the width of the treads should be the same.

Scaffolding.—Scaffolding, either permanent or temporary, should be of substantial construction and provided with guard rails and toe-boards when over 6 feet above ground or floor level. Scrap lumber should not be used for scaffolding.

Planks, boards, scaffolds, etc., resting on overhead ledges or beams, should be removed or fastened securely in place.

Tools, material, etc., should not be allowed to remain on scaffolds.

Tools.—Frequent inspections should be made by the foreman of all hand tools, appliances, etc., used in his department. Defective tools should be immediately withdrawn from service.

Tools, bars, etc., should be kept in boxes or racks, or securely hung low when not in use.

Window Glass, etc.—Broken glass should be removed immediately from windows, floors and passageways.

Where overhead skylights are not made of wired glass, they should be guarded underneath by a wire net or mesh to prevent injury due to falling glass.

Glass of pivoted windows, etc., should be of the wired type to prevent the falling of broken glass.

Miscellaneous.—All ropes, blocks, pulleys, cables, etc., should be inspected before being put into use.

Material stored on overhead platforms and tie beams should be securely stacked or fastened.

Guard casings or risers should be installed on edges of platforms to prevent material from falling.

Tools and other articles should not be stored or placed on top of lockers, closets, etc. Sloped tops prevent the storing of articles thereon.

Material should not be stored on window sills or ledges abutting passageways.

Shelving should be equipped with risers, especially that holding chemical containers and glassware.

Hammers with scored heads should be used in rough work to prevent nails from flying.

Guard rails should be placed across window openings where the sills are unusually near the floor. Sitting in windows should be prohibited.

Gas jets protruding into passageways at face level should be raised or removed.

Ladders, pipes, bars, etc., when carried on vehicles should not extend from the rear any further than necessary, and they should be at a height to give ample head clearance to pedestrians.

Foremen should be careful not to allow inexperienced men to operate machines, or perform other work of dangerous character, without first giving full instructions as to safe methods of operation.

Where a hose connection is used on a compressed air line, a cock or valve should be imemdiately behind the outlet nozzle. The hose should not be kinked to cut off pressure.

Hooks, nails or other objects protruding from wall into passageways, should be removed.

Ragged mats should not be left in doorways or passageways.

When necessary to handle heavy material, care should be exercised to see that a sufficient number of men is provided.

Bricks or spalls should not be used to block up pipe lines. Blocks of wood securely fastened in place, or pipe hangers, are suggested.

Goggles should be worn by men handling molten solder, lead, etc., or liquids where danger is likely to attend the splashing of same.

Horizontal exhausts into passageways should have vertical extensions to a height above a man's head, and be provided with a bleeder.

MANUFACTURING DEPARTMENT.

Boiler Room.—When boilers are connected in battery:

A non-return valve should be installed between boiler and header.

The blow-off from each boiler should be a separate line, unless each boiler connection is equipped with a cut-out.

Where blow-offs empty into a sump in or abutting a passageway, the pit should be covered and provided with a ventilating pipe extending 6 feet or more above the ground or walk level.

When a boiler is out of commission undergoing repairs, the steam valve, feed water valve, blow-off cock and surface blow lines should be tightly closed and locked, and a sign hung on valves reading "Under repair,—do not open valve."

Quick closing, lever handle, chain or rod pull, or automatic sealing cocks should be placed on water glass columns.

When opening valve of water glass column after installing new glass, the attendant should stand at a distance, and open valve slowly.

Safety valve outlets should have vertical extensions to a height above a man's head to prevent steam from injuring persons on top of boilers. Levers of safety valves should not be weighted beyond the rated boiler pressure.

Steam line outlets should be plugged or capped when not in use.

Water lines for wetting ashes should not be strung along boilers, owing to the likelihood of the employees being scalded by water they expected to find cold.

Loose bricks on top of boiler walls should be removed or rebedded.

Floors in front of boilers should be kept as free as possible of coal, ashes, etc.

Sharp bends in blow-off pipes should be avoided.

Coal Sheds and Trestles.—When coal and coke are being removed from bunkers or under trestles, care should be taken to see that pieces are not allowed to remain on top of the stringers, beams, etc.

Trestles should be equipped with foot walks and hand rails.

Guard bars about 12 inches apart should be placed across openings between tracks over bins and hoppers.

In emptying drop bottom cars, an approved type of safety wrench should be used.

A naked flame should not be taken into coal dust.

All persons should be warned to keep off smouldering coal piles or ash dumps, to avoid the likelihood of stepping into hidden fires.

Ladders leading to overhead walkways should be regularly inspected.

Engine Room.—Rail or screen guards should be placed around fly and belt wheels and pits for same. The lower panel of rail guards should be covered with wire mesh, or a floor riser should be installed around pit opening to prevent tools, etc., from dropping into pit.

High speed engines, in addition to having governors, should be equipped with automatic safety stops and speed limit devices.

Toe-boards or risers should be placed along the edges of all overhead engine walkways or platforms.

A safe method should be provided for turning over engines by hand.

Positive means should be provided for blocking vertical and large horizontal engines, compressors and pumps during adjustments and repairs.

When machinery cannot be conveniently stopped, due to operating conditions, provision should be made for oiling same from the outside of the guard rail, or automatic oilers should be provided.

Employees should not feel bearings, etc., of machines while same are in motion, except when absolutely necessary. Care should be taken that clothing does not come in contact with moving machinery.

No attempt should be made to repair piping, joints, etc., while same are under pressure.

Stationary ladders or stairways should provide access to such emergency valves as cannot be operated from the floor or platform level.

Tools or other obstructions should not be left on floors.

Exhauster and Blower Room.—Intake ports in side casings of blowers should be guarded or covered with meshed wire.

Generator House.—Frequent inspections should be made of floor plates to see that they have the proper bearing.

Seal pots should be covered or guarded.

Generator coaling doors should be securely fastened to avoid any liability of opening while under pressure.

No naked lights or flames should be near wash box while same is being cleaned.

When necessary to hold bars while sledging, tongs should be used.

Pipe extensions should not be used to give extra leverage on cotter bar handles.

When employees are working in shells, screen guards should be placed around openings.

Holders.—Stairways and platforms to holders should have intermediate rails in addition to hand rails. There should also be intermediate rails on galleries in front of syphons. (In adjusting the syphons the employee is usually in a stooping position, and his body is below the level of the hand rail.)

When stairways to holders are accessible to the public, guards should be placed around stairways, and the entrance gates kept closed when not in use.

Holder ladders and stairways should be kept free of ice.

Purifier and Oxide House.—Purifier boxes should be cleaned by not less than two men.

Guards should be placed around wheels of box lid carriers to prevent injuries to employees' feet.

Matches or open lights should not be allowed in purifier houses under any circumstances.

On doors and entrances to purifier houses, it is advisable to hang signs reading "Danger—no smoking—keep fire away."

Shoes having holes in the soles should not be worn, especially around oxide beds.

Retort House.—Charging and discharging machines should be equipped with signal devices (bell or whistle) to automatically give notice of change of position, and when electrically operated, with automatic terminal stops and circuit breakers. Wheel guards should be provded to prevent foot injuries.

Fuel should not be allowed to become unnecessarily scattered on floors.

Floor openings over hot coke chutes should have substantial coverings to prevent coke falling on man in cellar.

Cotter pins and nuts on coke buggy axles should be frequently inspected.

Reversing wheels on dumping carriages, sprockets, etc., of coal conveyors, should be guarded.

Shoes of employees engaged in clinkering should be snugly laced to guard against hot coke dropping therein.

Tar Separators, etc.—Covers or guard rails should be placed on or around tar separators, pits or stills.

Tanks.—Roofs and hatch covers of tanks should be made of substantial material and be inspected periodically. Open tanks should be provided with floats and life lines around sides.

Gas and oil tanks should be carefully purged before being entered. As an extra precaution, workmen entering tanks should wear life lines, held by others outside of the tanks.

Oil tanks should be provided with a vent pipe, preferably an inverted "U."

Yards.—Scrap lumber, fittings, pipe, etc., should be stored where they will not be likely to become tripping hazards.

Valve stems and boxes protruding above ground should be lowered to ground level or have guards placed around them.

Stakes, etc., should be removed where practicable.

Pipes, stop boxes, fittings, etc., should be securely stacked.

Where guy ropes cross passageways at face level, they should be guarded by flags and lanterns.

Exposed platforms should be well drained and kept free from dirt, ice and snow.

When breaking up cast iron or other metals, goggles should be worn.

All railroad frogs, switches and guard rails should be safely blocked.

Warning signs should be placed at railroad crossings when the latter are not guarded by watchmen.

Where doorways open directly on railroads, openings should be guarded by safety bars and signs.

DISTRIBUTION DEPARTMENT.

Driveways.—Driveways opening on public thoroughfares should be closed by gates where possible. If a gate is impracticable, signs should be conspicuously displayed, warning pedestrians and others of the danger incident to the driveway.

Motorcycles and bicycles should not be ridden on or across footways.

Horns of all motor vehicles should be sounded just before they are driven across footways. The local rules and ordinances bearing on the operation of motor vehicles should be learned and observed.

Excavations and Trenches.—When cutting paving or pipe, canvas or other shields should be set up along footways, and goggles should be worn, if chips are liable to fly.

Care should be exercised to brace or shore trenches where necessary.

Trenches and open manholes in districts where traffic is heavy should be barricaded. All trenches should bear danger signs by day and red lanterns by night. Care should be exercised to make back-filled trenches safe. Lanterns should be filled, trimmed and inspected before using.

Inspections should be made from time to time of trenches recently filled.

Paving stones, bricks, etc., should be carefully piled or stacked to prevent injury to pedestrians.

Service and tool carts, dirt or other street obstructions should be guarded by danger signs or red lanterns. Carts should be kept off highways at night whenever practicable.

In the placing of pipes and lamp posts along open trenches and on streets before installation, care should be taken to see that they are secure and that the ends do not extend over street crossings or unreasonably far out into roadways.

The greatest care should be used in the handling of dynamite, which should be delivered as far as practicable in the smallest quantities and as required.

Fitters, etc.—Should beware of vicious dogs on consumers' property.

Should see that trap doors, cellar doors, openings in floors, etc., if left open, are either closed or properly guarded.

Should always make meter and housepipe tests after turning on gas, to guard against leaks and open outlets.

Should test out all gas appliances after connecting.

Should report all leaks promptly.

Should see that meters are securely supported.

Condensation should not be left on consumers' property. If spilled, it may be deodorized with vinegar. In handling condensation employees should exert the utmost care to avoid fire or explosion. If it is not to be saved, it should be burned on paper in the open, by and in the presence of an employee.

Fire should never be used to thaw out a frozen pipe or meter.

Fitters and others should be warned against working alone in live gas.

Matches, candles, etc., should not be used to locate leaking gas. They are frequently used regardless of instructions.

Garages and Stables.—Garage floors should be kept as free from oils and grease as possible; slippery floors should be sanded.

Automobiles, motorcycles and other power driven vehicles and bicycles should be frequently inspected.

All horses and mules should be reasonably safe and steady, and should be in charge of experienced drivers only. Those inclined to bite, should be muzzled; if inclined to kick, should be disposed of.

When left standing alone, horses should be securely tied or weighted.

All harness, wagons, etc., should be regularly inspected.

All motor vehicles should be equipped with lamps and horns; bicycles with lamps and bells.

No smoking or use of exposed flame should be permitted in or around a garage.

No one except those on company business should be allowed to ride on company vehicles. Drivers before starting should see that children are not on or in contact with vehicles.

Shops.—Cutting and other tools, fittings, etc., should not be left lying around where persons may come in contact with same and be injured.

Gears, belts, pulleys, band and circular saws, planers and other machinery, should be guarded.

Nails should be kept in receptacles made for them, and not allowed to become scattered on floor.

Goggles should be worn where there is danger of getting foreign matter in eyes.

Scrap material should not be permitted to remain on floors.

Oil cans with straight spouts should be kept out of the way where persons would not be likely to fall on them.

Storeroom.—All bins, shelves and other storage places should be equipped with risers of sufficient height to keep material from falling out into passageways, and care should be exercised to prevent the overfilling of bins. The contents of bins should be arranged so that they will not protrude into passageways.

Alleyways between bins should be well lighted and kept free from obstructions.

Pointed bars or tools should be stored in proper receptacles with points down.

Appliances such as water heaters, radiators, etc., when stored in piles should be stacked securely to prevent falling.

Fixtures, tools, etc., when suspended overhead should be made secure and should be high enough to afford ample headroom. Hooks instead of nails should be used for hanging.

Nails should be drawn from barrels or bent over when removing heads, and from the tops of packing cases when unpacking.

Window openings in storerooms where used to store material or near places where material is piled, should be guarded by wire mesh screens or risers.

Miscellaneous.—When cleaning windows from the outside of building, safety belts should be used. These belts and the bolts in window frames should be frequently inspected.

The points of desk files should be guarded or bent over.

Flexible leads from sockets to telephones, electric fans, etc., should not be allowed to remain on floors and passageways.

WARNINGS, SIGNS.

Employees should be instructed:

To replace any safeguards removed before starting machinery.

Not to wear ragged clothing and to guard against their clothing being caught in machinery or belting.

Not to carry lighted pipes, cigars, cigarettes, or exposed flame, into places where there is a smell of gas or likelihood of an explosive mixture being present.

Not to tie up or prop up elevator gates.

Not to open or close any valve or switch or start any machinery with which they are not familiar.

Not to remove any warning or danger sign unless so instructed by someone in authority.

Not to use any defective tools or appliances, but to turn them in for repairs.

To invariably use goggles while chipping metal or scale; while working at grinding wheels and bulling standpipes.

To wear respirators and goggles while cleaning out combustion chambers and smoke boxes or working in an atmosphere heavily charged with dust.

Foremen should be instructed never to allow one man to undertake any job where there is a likelihood of his being exposed to live gas.

The use of signs as illustrated below is suggested. Those numbered from 1 to 6 inclusive, have been adopted by the National Association of Manufacturers and other trade associations. Arrangements have been made to secure these signs printed on linen, size 7 by 18 inches, through the Secretary of the Institute, at 60 cents per dozen.

The signs numbered from 7 to 20 are not kept in stock, but can be readily made up locally. It is thought that all signs except Nos. 6, 11, 12 and 20 are most effective with white letters on red backgrounds, and that Nos. 6, 11, 12 and 20 are most effective with white letters on green backgrounds.

1. DANGER.
2. DANGER. Do Not Touch.
3. NO SMOKING.
4. DANGER. No smoking; keep fire away.
5. RAILROAD—DANGER.
6. SAFETY FIRST.
7. FIRE EXIT.
8. BOILER UNDER REPAIR. Do Not Open Valve.
9. CAUTION—Driveway.
10. WARNING. Blow Horn Before Crossing.
11. PREVENT ACCIDENTS.
12. BE CAREFUL FIRST.
13. HIGH VOLTAGE.
14. MEN AT WORK ABOVE.
15. DANGER. Will Not Clear Man or Side of Car.
16. DANGER. Do not oil or wipe moving parts of machinery while same are in motion.
17. NOTICE. Running, wrestling, scuffling or indulging in any kind of play in any part of the works is likely to cause accident, and therefore is forbidden.

18. NOTICE. Do not move elevator until doors or gates are closed.

19. POSITIVELY NO ADMITTANCE.

20. WEAR YOUR GOGGLES.

SAFETY SLOGANS.

Safety slogans may be used to advantage. It is important to keep the idea of safety constantly before all employees. The following slogans are suggested and may be used as signs and on letterheads, pay envelopes, bulletin boards, etc.:

Be Careful.
Safety Always.
Prevent Accidents.
Boost for Safety.
Popularize Safety.
No Accidents.
Safety and Efficiency Go Hand in Hand.
The Safe Way is the Best Way.
The Best Way is the Safe Way.
Be Careful First.
Taking Care, Not Chances, Means Safety.
Safety Pays.
Follow the Safe Course.
Carelessness is Dangerous.
Think About Safety.
It is Better to Cause a Delay than an Accident.
It Takes Less Time to Prevent an Accident than to Report It.
Stop and Think—Be Careful.
Think About Safety To-day, To-morrow and All the Time.
Do Your Share Towards Cutting Down Accidents.
Hit the Safety Trail and Stick to It.
Fall in Line with the Accident Preventers.
Don't Forget that Safety Follows Care.
Watch for Danger Points and Report Them.
To Avoid Danger, Follow the Safe Course.
Acquire the Safety Habit,—It Will Help You.
Don't Be Afraid of Taking Too Much Care.
Better Wear Goggles than Lose an Eye.
A Careful Man is the Best Safeguard.
Don't Take Unnecessary Chances.

MOTION PICTURE.

The Committee has just completed a motion picture film on accident prevention. In it various causes of accidents and measures designed for their prevention are shown. To increase interest in the film, life pictures of the past presidents and officers of the Institute have been included.

In view of the distinct educational value of motion pictures in accident prevention work, it is believed that this picture will be much sought by the members of the Institute for display at employees' meetings and safety rallies, along with the accident prevention slides presented to the Institute last year.

In order to help defray the cost of making the motion picture for the Institute, it is suggested that a charge of $10 be made for each day it is in use, in addition to the cost of expressage.

To give a fair idea of the picture, the following resumé is included in this report:

BE CAREFUL FIRST.

Arranged for the American Gas Institute, 29 West 39th St., New York City, by its Committee on Accident Prevention.

Copyright, 1915.

Title No.	Scene No.	
1		View of gas works.
	1	Same.
2		When rolling barrels with hands on the ends, fingers are liable to be crushed as shown.
	2	Unsafe way of rolling barrels.
2-a		The safe way is to roll with the hands on sides of barrel.
	2-a	Safe way of rolling barrels.
3		Tools left in passageways cause accidents; when not in use they should be kept out of the way, preferably in racks.
	3	Tools in passageway; workman stumbles on rake.
4		Handle of fire hose reel left at face level, a bad hazard.
	4	Workman winding fire hose.
4-a		Handle should not be left in position. Note same being hung inside of reel box.
	4-a	Hanging handle inside.

Title No.	Scene No.	
5		Pickaxe carried on shoulder with point outward, liable to injure pedestrians.
	5	Workman carrying pick with point outward.
5-a		The safe way to carry a pickaxe is with point down.
	5-a	Workman carrying pick with point down.
6		Protruding nails in barrels injure workmen's arms.
	6	Workman injured by nail while placing rubbish in barrel.
6-a		Nails should be bent over or removed when barrels are first opened.
	6-a	Workman bending over nails in barrel.
7		Hoops when stepped on are liable to spring up and break workmen's kneecaps. The best place for loose hoops is the scrap pile.
	7	Workman stepping on a hoop.
8		At times it is not thought necessary to inspect trenches, which later cave in.
	8	Workmen in unshored trench; showing cave-in and removal.
8-a		The safest way is to inspect all trenches, and when in doubt, set up shoring. Unnecessary chances should be avoided.
	8-a	Properly shored trench.
9		Cross bars bracing legs of fuel buggies and wheelbarrows catch and injure workmen's heels.
	9	Workman pulling fuel buggy, injures heel.
9-a		Such bars are usually unnecessary and should be removed.
	9-a	Workman pulling buggy without bar.
10		Serious eye injuries follow failure to wear goggles when working in heavy dust.
	10	Workman shovelling in dusty atmosphere.
10-a		It is safest to wear both goggles and respirator.
	10-a	Workman wearing goggles and respirator.
11		Standing on a barrel, particularly when working around windows, is a dangerous practice.
	11	Workman standing on a barrel at a window.
11-a		The safest and easiest way is to use a stepladder.
	11-a	Workman using stepladder.
12		Boxes of matches placed in holders with the heads up are liable to be ignited by the flash following the striking of a match, and to cause burns.

Title No.	Scene No.	
	12	Box of matches with heads upward, flashes and burns hand.
12-a		Placing the heads of the matches downward does away with this hazard.
	12-a	Box of matches with heads downward; doesn't flash.
13		At times motor vehicles left standing with brakes set, on down grades, run away. Note the wheels parallel with curbs.
	13	Truck is driven up and left at curb.
13-a		The danger of runaways and consequent accidents can be avoided by turning the front wheels against the curb after setting brakes.
	13-a	Automobile is driven up to and left at curb with wheels turned against same.
14		Gates opening out over streets are liable to strike pedestrians.
	14	Gates swinging out and striking pedestrians.
14-a		The hazard is removed by making gates slide or swing in.
	14-a	Sliding gate.
15		Pedestrians are often injured by employees riding across footways on bicycles or motorcycles.
	15	Messenger boy in collision with pedestrian on footway.
15-a		Employees should dismount before crossing footways.
	15-a	Messenger boy leading bicycle across footway.
	15-b	Workman leading motorcycle across footway.
16		Past Presidents of the American Gas Institute.
17		B. W. Perkins, 1906.
	17	B. W. Perkins.
18		Walton Clark, 1906-1907.
	18	Walton Clark.
19		A. C. Humphreys, 1907-1908.
	19	A. C. Humphreys.
20		C. F. Prichard (Deceased), 1908-1909.
	20	Photograph of C. F. Prichard.
21		W. H. Bradley, 1909-1910.

Title No.	Scene No.	
	21	W. H. Bradley.
22		Donald McDonald, 1910-1911.
	22	Donald McDonald.
23		I. C. Copley, 1911-1912.
	23	I. C. Copley.
24		W. R. Addicks, 1912-1913, during whose term Accident Prevention was officially recognized by the Institute.
	24	W. R. Addicks.
25		W. H. Gartley, 1913-1914.
	25	W. H. Gartley.
26		Delegates to convention at Richmond, Va., when Accident Prevention was first brought before the Institute.
	26	Photograph of delegates.
27		E. C. Jones, President, 1914-1915.
	27	E. C. Jones.
28		Geo. G. Ramsdell, Secretary and Treasurer.
	28	Geo. G. Ramsdell.
29		Join your friends in boosting for Safety. Be an Accident Preventer.
30		Safety BOOST SAFETY GAS CO. CARE CAUTION PREVENT ACCIDENTS Button.

First Aid.

The Committee has also been at work on the preparation of a standard booklet on General First Aid, but at the present time, the results accomplished do not warrant anything more than a report of progress. It is thought that next year's Committee will be able to bring this work to a satisfactory conclusion.

Contributions in the form of "Accidents That Could Have Been Prevented," accidents of a peculiar nature, photographs, etc., have been published from time to time by the Committee in the Institute *News*.

The use of safety bulletin boards in and around the plants is advocated. Attention is also drawn to the wearing of safety buttons by employees, as suggested last year. The standard button is reproduced on the cover of this report.

The Committee in retiring wishes to thank the members of the Institute for their assistance, and trusts that they will make use of the results of its efforts.

Jas. B. Douglas, *Chairman,*
H. E. Almberg,
H. C. Blackwell,
C. M. Cohn,
E. H. Earnshaw,
H. W. Peck,
C. E. Reinicker,
J. W. Shaeffer,
C. H. Stewart.

Mr. G. I. Vincent (Des Moines): (Written discussion communicated.) I have read the report of the Committee with a very great deal of interest, and my only criticism is that it is so complete that it is absolutely impossible to add anything to it by discussion.

The features of it that appealed to me particularly are the charts showng graphically the causes of accidents, and suggestions for the safety organization. The rules and precautions, and general precautions for the guidance of the accident and hazard inspector are also very useful and valuable.

To your list of signs on page 81 of your report we have added the two following. The sign (Fig. A) referring to the use of defective tools is posted in practically every place where tools are used by workmen; for instance, at various points around the works and shop, and also in each tool cart on the street. The idea of this sign is that even the most careful inspection will not insure tools being in perfect condition at all times, and we must necessarily depend on the workmen using some judgment in regard to using their tools. It seemed to me that we could go to some length to provide drastic penalties for the disobedience of this rule. In other words, it seemed to me more than an educational proposition.

NOTICE

THE USE OF DEFECTIVE TOOLS BY ANY EMPLOYEE IS FORBIDDEN. ANY EMPLOYEE DELIBERATELY USING A DEFECTIVE TOOL WILL BE SUBJECT TO DISCHARGE. REPORT DEFECTS TO FOREMAN.

SAFETY FIRST

Fig. A.

The second sign (Fig. B) is along the same line, and is self-explanatory.

(Post in conspicuous place near any machines fitted with safety devices)

SAFETY FIRST

These machines are equipped with safety attachments. Employees must see that the attachments are in place before operating the machine.

SAFETY FIRST

Fig. B.

Mr. H. B. Andersen (Philadelphia): (Written discussion communicated.) On page 64 certain specifications are given to show the proper installation of elevators and elevator gates. Several months ago the Committee in Charge of Accident Hazard Inspection recommended that the gates then in use on the elevator in our shop be changed so that they would conform, in general, to specifications which were practically those mentioned in the report. We asked for bids from elevator companies accordingly, and received one from one of the best companies in the country to whom we awarded the contract to proceed with the new safety gates. After the work of installation had been completed, we found that the new gates were so heavy, even though their construction was not specially strong, that it was very difficult for some of our men to lift them. We felt then that although the dangers had been decreased in one direction, they had been greatly increased in another, through the possibility of a man straining himself while lifting the new gates. The lesson to be learned here, we believe, is to make all gates of light construction and so easily working that there will be no danger of this kind created. It is easy to specify the kind and size of timber from which gate frames should be made. The tendency is to specify wire net, of unnecessarily small mesh, adding greatly to the weight. I believe that a square or diamond mesh of four inches of suitably heavy wire is sufficient for all ordinary purposes.

On page 78 fitters are cautioned to "always make meter and housepipe tests after turning on gas to guard against leaks and open outlets." The importance of correctly making the turn-on test was again impressed on us by a recent occurrence where the fitter, after testing the meter and finding it registering properly, made the connection to the housepipes and noted the position of the dial hand and started to write up his work order. He did not "expect" that a leak existed, but when he again looked at the hand, he saw that it was moving rapidly. He shut the gas off at once and found the far end of the gas stove line, underneath the second floor, to be open. He made this tight and was about to leave the house when an explosion occurred under the second floor, causing considerable damage, but fortunately injuring no one. Our written rules on making the meter and housepipe tests, state specifically that the man should "watch" the dial hand. The word "watch" is capable of no two proper interpretations; the one proper interpretation being to keep looking at the dial hand. The failure of the fitter to literally obey instructions was the cause of this explosion. The lesson to be learned is that when rules are carefully written, this fact should be impressed upon the workmen, and inspectors or instructors should enforce these rules to the letter. Very often rules are at fault and those persons in charge of issuing instructions should be careful to write rules that are capable of but one interpretation.

On page 79 the subject of goggles is mentioned. It is not enough to say that goggles shoud be used, because experience has shown that improper goggles are far worse than no goggles at all. Where the use of goggles is desirable, the goggles themselves should be of the best type obtainable and should be kept in perfect repair. It is especially desirable to furnish goggles with ample ventilation, so that perspiration will not dim the sight.

MR. G. R. ALTHEN (Baltimore): (Written discussion communicated.) Relative to the report of the Committee on Accident Prevention, the following comments are offered covering phases of the subject which it might be advisable to include in its discusson and which might be applicable to the gas industry as a whole.

It is noted at the beginning of the report that a graphic analysis showing the causes of accidents is made. It might be well to suggest that each company compiles a similar analysis covering accidents in its own organization which might be useful, upon being analyzed, in minimizing those classes of accidents which seem to have a preponderance. For example, the prevalence of a certain class of accidents may be due to the defective condition of a certain type of tool, or perhaps the inefficient manner with which the tool is handled.

No mention is made of the importance of sanitary conditions surrounding the employee. This is a very important consideration and one which would properly bear careful investigation and constant inspection.

No mention is made of the importance in selecting employees who are physically able to pursue their duties. This suggests the advisability of instituting a plan of physical examination of all prospective employees. For example, a man may be employed by the fitting department who is devoid of an acute sense of smell.

It would be advisable to have certain men in each department of the organization trained in capably rendering "first aid" treatment.

"First Aid" cabinets should be located in easily accessible places and should have a competent person in charge, whose duty it should be to see that they are replenished with fresh supplies from time to time.

It is desirable to have inspections of each department made by men connected with other departments, with a view to deriving some benefit from the viewpoint of those who are not closely identified with the operations in the department inspected.

It would be well to renew the personnel of safety committees from time to time with a view to instilling new ideas, or ideas which might possibly have been overlooked by the old Committee.

A close analysis of rule books issued by many of the gas companies might bring to light suggestions along the line of accident prevention which might be of benefit to the entire industry.

A day selected periodically, known as "Clean-Up Day" has been found of value to this company in furthering the cause of accident prevention.

As an incentive for producing results, it would prove to advantage to offer small money prizes to those submitting the best suggestions along the line of accident prevention.

Besides adequate fire protection equipment, fire drills are essential at the shops and the manufacturing plant.

Automobile Equipment: Each automobile should be equipped with a fire extinguisher and a complete equipment of tools.

Wagons: Instead of tying or weighting horses, a chain lock at the wheels could be used, and which device is very effective.

Elevator Equipment: A signal bell, notifying the approach of the elevator, is desirable.

Heavy Weights Lifted by Employees: Care should be taken to see that the men are not taxed beyond their strength in lifting heavy weights. This would apply especially to the delivery and installation of appliances and the handling of storeroom material.

Operating Valves: Any valve, the operation of which might prove dangerous, should require a wrench to open and close.

Protecting Property of Others: Underground structures, such as sewers, drain pipes, .conduits, water pipes, etc., the property of others (where uncovered) should be properly protected to prevent damage. When it is observed that damage is being done to the property of others, in the vicinity of the work, and there is a possibility of the company becoming involved, the condition should be reported to headquarters at once.

Notifying the Fire Department: Before opening a trench at the inersection of two streets, or where a street is unavoidably closed to traffic, the Fire Department should be notified.

Trench Crossing Under Steam Railroad Tracks: Whenever a trench is made, either crossing or between steam railroad tracks, and there is danger from passing trains, watchmen should be placed at convenient points to inform the workmen of approaching trains.

Surplus Dirt: All surplus dirt and other unnecessary material left over after back-filling, should be hauled away and the thoroughfare left in a safe condition.

Handling the Derrick: Before using a derrick for laying mains, it should be carefully inspected to see that the drum and ratchet attachment are in good condition, that no teeth are broken out of the cog wheels, and that the ropes, block and fall, are in good condition. The derrick should set firm so that there is no possibility of falling.

Assistance when Tapping Mains, etc.: When making connections or tapping mains, where there is a likelihood of gas escaping, a man should be conveniently stationed to render assistance if required.

Use of the Rubber Safety Plug: When, in installing a service, a tee is screwed into the main, the proper size rubber plug with iron screw plug follower should be inserted in the run of the tee until the service is completed. If a portion of the trench is back-filled to maintain driveway, that part of the trench at the main should be left open so that the rubber plug can be used. The rubber plug with screw plug follower, is found to be very effective in shutting off gas from the service where it enters the building whenever any work is being done at the meter or on the house side.

Use of Intoxicants: The use of intoxicating liquor during lunch or working hours should be forbidden.

Pipes Charged with Electricity: If, while working at the service, meter or house lines, it is found that the pipes are charged with electricity, a report should be made promptly to the department.

The Adjustment of Appliances: It is extremely important that all burners should be properly adjusted after an appliance is installed.

Appliances Operated by Air Blast: When connecting appliances operated by an air blast, such as brazing torches, fire heaters and soldering furnaces, extreme care should be exercised to see that there is no possibility of air getting into the gas system. The gas line to such appliances should be equipped with an approved safety valve or governor, to obviate this possibility.

Emergency Service: An emergency automobile, equipped to handle any contingency, can render important service in preventing serious accidents. The equipment should include, besides a complement of tools, a Draeger oxygen apparatus. A pulmotor should also prove a valuable addition to the equipment.

MR. VICTOR VON STARZENSKI (Schenectady, N. Y.): (Written discussion communicated.) Page 62, last paragraph, the standard sized form 8 by 11 inches is recommended. 8½ by 11 inches is the size generally in use.

At various places in the report smoking is prohibited. It seems that a general rule should be laid down that smoking be prohibited on gas works property. The reason for this is, that if a man smokes in a place that is safe he may thoughtlessly enter a dangerous room with disasterous results.

On page 71, under "Scaffolding" it says:—"Scrap lumber should not be used for scaffolding." It might be well to specify the use of spruce for this work, as hemlock and woods of similar strength are dangerous to use.

On page 75, under "Generator House," no mention is made of the care that should be taken in opening up coaling doors, at which time a dangerous flash is liable to occur.

On page 75, paragraph reads "Pipe extensions should not be used to give extra leverage on cotter bar handles." I am sure that no one will follow this rule, and therefore it should be omitted, as on a machine that has been running a long while, the cotter bar may be set up, making it absolutely necessary to use a pipe extension.

Under "Holders," page 75 no mention is made of the danger of accumulating too much snow on holder crown.

On page 77, under "Distribution Department" it should be mentioned that gas main taps always should be made by two men.

It is also important when cutting in tees on old mains that the line be thoroughly gassed when the job is done, otherwise the volume of air may travel to the consumer's burners, extinguishing them, and allowing the gas to escape after the air has been purged.

On page 78, under "Garage and Stables" I believe that mention should be made of the great importance of following the rules of traffic. Disregard of these rules is a prolific cause of accidents. In this connection I would call your attention to the fact that on page 85, describing scene 13 of the moving picture film, where the truck is shown to cross over from the right to the left side of the street, it came to a halt headed in the wrong direction. This seems like a flagrant violation of traffic rules which should be censured.

MR. J. B. DOUGLAS (Rejoinder to Mr. von Starzenski): The wrong location of the truck to which attention is called above is due to what might be termed "photographer's license." The place at which the picture was taken was the only suitable one we could find, as not only did foliage make the light poor on the other side of the street, but obstructions there would have interfered with getting a clear panoramic view through the camera.

MR. R. B. DUNCAN (Philadelphia): Written discussion communicated.) There is no doubt that the report of the Committee on Accident Prevention, both from the standpoint of causes of accidents and the many means of preventing them, is very thorough and complete. There is, however, one point that I believe should be more deeply gone into,—that of having the complete co-operation of all the employees in a company where this subject is of such vital importance.

The other fellow's ideas are not worth a cent to us so long as they remain exclusively the other fellow's, but it is a peculiar property of ideas that they can be shared with any number of people without decreasing the supply of the original owner. We lose none of our ideas by sharing them with others; they lose none of theirs by sharing them with us. The actual result is that each of us has twice as many ideas as he had before, and surely that is worth while.

There are many forms of accident insurance nowadays, but the best of them all is that which aims at prevention. The best form of accident prevention in the plant, shop, or on the street, is in making the "factor of safety" so high that it will take care of every conceivable emergency of ordinary operation.

It is my belief that, unless every man in the employ of a company, is made to see that his work is closely related to that of the other fellow, and that one weak link in the chain impairs the strength of the whole organization, success will not follow. There is no better way to arouse this enthusiasm than to work through a man's pocketbook. Give him a chance to make a few dollars by offering prizes for the best suggestions, and you will be surprised to find out how many accident hazards you have around your place that have never come to your attention before.

Chairman Forstall: Now we have the report of the Bureau of Information.

REPORT OF THE BUREAU OF INFORMATION.

The Bureau of Information appointed by the Technical Committee for the business year of 1914 to 1915 submits the following report:

This report covers the work from October 1, 1914, to September 1, 1915, as the annual meeting of the Institute is in September instead of October as heretofore.

Questions.	
Unanswered, October 1, 1914	33
Asked, October 1, 1914 to September 1, 1915	50
Total	83
Answers.	
Voluntary	13
Solicited at large	29
Answered by members of Bureau	19
Answered by Bureau	20
Total	81
Unanswered	2
Total	83

A great many questions have more than one answer.

Following is a table of the questions and answers since the year 1906:

Business year	Questions asked	Answers given
1906-1907	8	8
1907-1908	32	30
1908-1909	15	15
1909-1910	14	14
1910-1911	10	10
1911-1912	48	34
1912-1913	109	106
1913-1914	98	132
1914-1915	50	81

In the report of March, 1915, the Bureau called attention to the small number of answers that were voluntarily given to the questions asked, pointing out the fact that a great deal of the value of the Bureau is lost unless the members of the Institute, of their own accord, voluntarily send in answers to the questions upon which they are especially fitted to write. Lack of interest in voluntarily answering the questions seemed to the Bureau to be a poor sign that its work was appreciated, but it now has a still more unsatisfactory condition to report, namely: that from March 1 to September 1, 1915, only 18 questions were asked, making only 50 for the year.

It has been the endeavor of the Bureau to answer all questions promptly, and to clean up all the old back questions, in order that its time may be devoted to answering questions promptly and completely, the Bureau feeling that an answer is much more valuable if published while the question is still a live one.

The previous Bureau, for the year 1913-1914, stated in its report that "the interest shown seems to be a stimulated one, rather than one originating within the individual members and others."

The tables giving the questions asked each year since 1906 would rather indicate that the above statement was and is true, as the previous Bureau gave considerable publicity to the requirement of questions and obtained 98, whereas the Bureau this year has given more attention to the requirement of answers to the question already given, and obtained only 50 questions.

This whole situation in regard to the work of the Bureau brings up several questions:

1st. Is there a real need for a Question Box? It would appear, if the questions have to be solicited and advertised for, that the need is artificial and not real.

2nd. If the need or reason for the Question Box or Bureau of Information is artificial, could not the work of the Bureau be turned to a better purpose?

3rd. Is it of more benefit to the Institute to have a very large number of questions asked and answered, as some other associations do, than to have comparatively few questions thoroughly and completely discussed?

4th. If the work of the Bureau is going to be very much augmented in any way, it should be reorganized on different lines.

It should be conducted by a paid secretary working in conjunction with or under the direction of the secretary of the Institute. The work of the Bureau should be given considerably more prominence in the *News*. The present method of handling this work is unnecessarily slow, complicated and unsatisfactory, in every way.

The above remarks and suggestions are respectfully submitted for the consideration of the Institute, and especially the Technical Committee.

DANA D. BARNUM, *Chairman*,
OSCAR H. FOGG,
EWALD HASSE,
FRANK E. LUTHER,
W. B. OSBORNE,
R. S. SCOTT,
C. C. SIMPSON, JR.,
G. I. VINCENT.

Chairman Forstall: The next is a report of the Committee on Carbonization, of which Mr. O. B. Evans is chairman. I will ask Mr. Evans to present it in abstract.

Mr. O. B. Evans (Philadelphia): The report of the Committee on Carbonization is rather lengthy, and of such a nature that I do not think it could be profitably presented even in abstract at this time. I would request permission, therefore, to read it by title only.

REPORT OF THE COMMITTEE ON CARBONIZATION.

(A) INTRODUCTION.

The report of the Carbonization Committee for the past few years has consisted almost entirely of descriptions of new coal gas installations. The continued business depression has, however, restricted the construction and development of coal gas benches to such an extent that it seemed advisable for this year's committee to depart from this practice, and to make a study of coke. The report, therefore, gives one of the theories of the formation of coal, describes the mining of coal and the usual methods of preparing it for the market, presents the results of numerous investigations upon the effect of storage on coal, and on the strength of these, makes certain recommendations. A general outline of the coke requirements for metallurgical and domestic use is given, together with a description of the usual methods employed to produce a metallurgical coke. The report concludes with some remarks upon the formation of coke, and describes several series of experiments showing the effect of various methods of carbonizing upon the character of the coke produced.

(B) COAL.

1. *Formation of Coal.*

According to Vivian B. Lewis (*Progressive Age,* Dec. 15, 1911, p. 1030) coal consists of:

> "An agglomerate of the solid degradation products of vegetable decay together with such of the original bodies as have resisted to a greater extent the action to which they have been subjected."

and as such consists of a mixture of hydrocarbons which baffles chemical examination as to nearly every point other than its ultimate composition.

Probably the most generally accepted theory is that coal consists of substances which have all come from two original forms of vegetable products, *viz.*: cellulose or lignose, and resinous bodies such as the spores of the lycopodia. The proportion of the two constituents originally present, together with the effect of decomposition, temperature and pressure, altered the character of the changes undergone by the original vegetable mass, and determined the character of the ultimate coal. Quoting again from V. B. Lewes:

> "If we start with the humus and resin constituents as they exist in the peat deposits of to-day, the latter are present only to the extent of 5 to 10 per cent., but in the decaying vegetation of the carboniferons were probably present in much larger quantities, and the humus, unprotected by it, underwent decomposition with concentration of carbon and evolution of methane, carbon dioxide and water. As the layer of deposit above the carbonizing mass grew thicker, so probably the temperature rose, and the ratio of resin constituents increasing in proportion, bound together the mass and so helped to protect the remaining humus, and with the lapse of centuries lignite was formed.
>
> "If the amount of resin constituents was small or had not been evenly distributed throughout the mass, the lignite was loose in structure, and during the ensuing ages continued decomposing until, if the pressure had been great and the temperature high, nothing but the residual basis and trace of resin constituents were left in the form of steam coal or anthracite, while under other conditions they may have remained mixed with the bituminous coal in a seam and formed "Mother of Coal."
>
> "If the percentage of resin bodies was very high, as in a drifted deposit of spores from lycopodia, and the temperature high, the resin bodies may have become semi-liquid and mingling with surrounding earthy deposits, given such compounds as the Boghead cannel, the organic matter in which has the same composition as resin, while it yields 33 per cent. of ash.

> "When the temperature has been high enough, some of the resin constituents practically distilled into the underlying clay, yielding some forms of shale."

2. *The Mining and Preparation of Coal.*

Mining coal, especially in the Appalachian fields, is usually accomplished through drift entries, although in some districts the vein is reached through slope or shaft entries. When the virgin vein is reached, rooms from 16 to 18 feet in width are driven, radiating from these entries, leaving pillars of coal from 32 to 34 feet in thickness; this is known as the "panel" system. When these rooms are run to their extremity and this part of the mine is ready to abandon, the pillars are drawn. The method of driving these entries and rooms is largely by means of puncher and chain machines, which make undercuts in the face of the coal ranging from 4 to 15 inches in height, with a depth of 3 to 7 feet and a width of 3 to 5 feet. This undercutting is usually made at the bottom of the coal seam or in the center, depending on the thickness of the seam and upon other mining conditions.

In some mines where a distinct mud seam runs through the vein, the cut is made so that it will remove as much of this foreign matter as possible, the material of the cut being cleaned up before the coal is picked or blasted down for removal in tram cars.

There is usually from 4 to 12 per cent. of foreign matter inherent in all the veins of the so-called gas coal. An effort is made by many companies to eliminate as much of these impurities as possible before the coal is removed from the mine. In most cases this is accomplished by a docking or fining system, the efficacy of which rests primarily upon the thoroughness of inspection and the initiative of the officials.

After the removal of the coal from the mines, the operation of separating it into the different commercial sizes by passing over shaker, knocker or bar screens, and through a system of chutes or inclines, offers other opportunities for the removal of foreign matter that may have been left in. This is accom-

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plished by pickers stationed at different points along the coal passage and in the railroad cars, who being trained for this work detect and separate from the coal much of the refuse left in it. It is apparent that on account of the large quantity and rapid passage of the coal, this system is very inefficient as far as the removal of all the foreign matter is concerned, and may account for much of the variation in the product coming from the same mine and district.

As far as can be ascertained, with a few isolated exceptions, no attempt is made to separate the impurities by washing, or by means of the gravity method through the medium of water.

Notwithstanding the precautions taken by the companies in eliminating all refuse from the coal, much foreign matter, such as mine couplings, cleavices, brake shoes, picks, dynamite, powder, etc., comes through in the cars. This not only menaces the safety of the employees engaged in unloading and crushing the coal, but does a great damage to the unloading and crushing machinery, to say nothing of the possible injury to the retorts by the fluxing action of iron. With the enormous increase of output, these articles are found with such frequency that nearly all companies have been forced to employ devices which prevent their ingress in the machinery, or else have installed safety equipment which throws the machinery out of clutch or shuts off the actuating power.

The prevalent method of preventing metallic articles from reaching the vitals of the machinery is by magnetizing a drum over which the coal passes, the metallic substances being attracted to the drum and dropping off at a point beyond the coal receptacle. Shearing pins of wooden material passing through a double or split hub on the driving pulley, loose driving belts, cut-out switches, safety fuses and minute inspections are other methods of coping with this nuisance.

The Bradford breaker is also often used with success in the removal of foreign material. It is to be hoped that in the near future the coal companies will provide equipment in their loading tipples which will remove articles of such destructive character and thus relieve the buyer of this expense.

The usual or prevalent system of screening gas coal, even among large coal companies, is by the use of bar screens. This fact explains, in a degree, the great amount of slack found in the so-called ¾-inch screened, and may be the reason for much of the fluctuations in the quality, as a large share of impurities is generally in the finer divisions of coal.

It is very gratifying to state that some of the larger companies are not only adopting a screen that is more positive in its operation, but are prepared to guarantee the delivery of a ¾ inch coal with the slack entirely eliminated.

The fact that nearly all coal fields vary as the mining of certain seams or veins progresses, is admitted by most coal companies. Working on this basis, a few of the more progressive take samples and make analyses with sufficient frequency to enable them to detect and record any radical change in the structure and quality of the coal which they may be furnishing on contract. These analyses take into consideration the volatile, sometimes fixed carbon, moisture, ash and sulphur contents.

The majority of companies, though it is lamentable to state, neglect this very important matter, depending upon visual observation and complaints from buyers for the detection of any changes that may occur in the general uniformity of the coal which they send out.

The moisture content in gas coal as it stands in its virgin state in most districts runs from 1 to 2½ per cent. This amount may be materially increased if the mine is improperly drained. During the passage of the coal from the mine to the consumer, the water content is purely an incident of weather conditions, and may be materially increased or slightly decreased from the figures given above. The handicap that water conditions offer in the mining of coal has a tendency to keep the water content, as it leaves the mine, to a minimum.

Loss of coal, due to errors in weight, transfer of the contents of cars and thieving in transit, is a question which is being considered by some of the larger consumers. The coal is billed upon weights which in some districts are arrived at by the railroad companies, and in others by the shipping company. Both the railroad and the coal companies will make the assertion that the overage in the course of a year will equal the shortage. In some specific cases this has been disproved, and leaves the question open. There is little doubt that there is a great loss, especially on long hauls and through terminal cities, due to thieving. The fact that the top of the car always contains a great proportion of the large lumps, facilitates the easy removal of this portion of the coal in its passage from the mines to the consumer. By loading the cars with the fine material in the bottom and the large lumps on top, the car makes a better appearance and undoubtedly there is less danger of coal being accidentally spilled over the sides in transit; still from the point of view of the gas man, the practice is objectionable and should be discouraged.

It is stated that much of the coal used by tug-boats in the coal trade, in railroad camps, by section shanties, and by foreign population near all coal carrying roads, is not purchased. The annual shortage due to thieving and errors in recorded weights is of such consequence that many of the large companies have installed scales, and check all cars received by them.

Coal as a rule is sold through brokers, except among the largest companies. These large companies have representatives in all the big cities in the country. It is very difficult to obtain a commodity of such tonnage through a second or third party and then hold any one in particular responsible for its quality or uniformity. It is a well known fact, regardless of how iron-clad the contract may be, that coal brokers switch shipments of coal to suit their own convenience with little regard to the loss and trouble their customer may be put to. In view of these conditions, it is a wise and safe plan to place coal contracts with those companies who are reliable, who personally control their own output and who are responsible in every way for the quality and uniformity of their product.

While heretofore but little gas coal has been bought upon specification, it is believed that such a basis of purchase is the only satisfactory one from the standpoint of both buyer and seller, and your Committee recommends that insofar as possible efforts should be made to buy coal in this way. While it is impossible to draw up a specification which would fit unknown local conditions, it is suggested that the following points be considered in drawing up such a specification.

The mine from which the coal is taken.

The descriptive characteristics of the coal as to its outward physical quality and appearance.

The size of lumps, and the maximum quantity of fine material.

The loading of the cars if theft is an important consideration.

The kind of cars.

The method of sampling coal.

The method of analyzing samples.

The analysis should specify the quantity of:

Volatile combustible,
Fixed carbon,
Moisture,
Ash,
Sulphur,
Fusing temperature of ash.

It is recommended that the sampling and analysis be conducted in accordance with the rules now being compiled by a committee of the American Society for Testing Materials.

All gas companies, regardless of whom they buy, should have a routine system of sampling and testing the receipts of all coal, as it is unloaded in their plants. When the contract is of sufficient size, it might pay the gas company to have an inspector at the mines to look after its interests by keeping in daily touch with the output of the mine or mines from which the contract is filled. This would be a safeguard and a check, which should eliminate any impairment to the quality of the coal.

There is a recent tendency among the mine owners to view with less indifference the requirements of the purchasing companies for a supply of coal of uniform quality in keeping with the specifications under which a contract is made. A more scientific knowledge on the part of the coal companies, of the commodity which they sell, and a more definite idea of the requirements on the part of the buyers, have done much to bring this attitude about. Special representatives familiar with the gas situation are being employed by some of the large producers, whose duties are primarily to keep in touch with the gas man's point of view. There is little reason or cause for any misunderstanding to exist between the seller and the buyer of a commodity representing such a vast business to both parties.

3. *The Storage of Coal.*

The question of the losses due to storage of gas making coal brings up at once the matter of how much material shall be stored.

The ideal conditions would be met by deliveries regulated exactly by the demand, but the necessity of providing stock to take care of the uncertainty of supply, transportation, market conditions, or interruptions in service, demands the provision for storing a large percentage of the annual tonnage.

Storage may be exposed entirely to weather, covered in various kinds of bins or under water. The choice of the system must be settled by local conditions. Under water storage has been successfully used with steam coals, but thus far in this country no report of such storage of gas coals is known. The Stettin Gas Works is reported having under water 20,000 tons of gas coal, and having saved 8 per cent. in gas yield and 30 per cent. in ammonia.

M. Rolland D'Estape (*The Gas World,* June 27, 1914, p. 960) reports no trouble was experienced in handling with the DeBrouwer conveyor, 3,200 tons of nut coal stored in a concrete silo and covered with water. After some months the results were "absolutely comparable to those from fresh coal."

Against any loss due to deterioration when stored in the open, if compared with covered or under water storage, must be charged the interest on the investment necessary to erect the covered storage system, any extra handling needed and any other costs entering the system.

The losses would be those noted either in value or amount of residuals, coke, tar, ammonia and the loss in candle-feet or thermal feet in the gas, and any direct loss due to spontaneous fires in the piles and difficulty of handling when frozen.

In the matter of losses due to weathering in the open, there is a very wide difference of opinion, different authorities quoting from 3 to 25 per cent. loss in the gas made per ton of coal carbonized. There seems to be an agreement in the loss in quality of coke. Earlier German experience is summarized by Herr Prenger in the 1909 *Proceedings* of the German Association of Gas & Water Engineers (*Journal of Gas Lighting*, Sept. 21, 1909, p. 761) on the "Storage of Coal." Quoting from the above article:

"It is, however, generally acknowledged that the yield of gas rapidly begins to diminish more or less, and that the diminution increases greatly with the duration of the storage. Thus, Grundmann has given figures, showing for Ruhr coals, reductions in the yield of gas of $^{9}/_{10}$ to over 7 per cent. on storage for only 14 days, of 3.2 to 12 per cent. in 150 to 160 days, and of 8.1 to 17.2 per cent. in 370 to 381 days. Experiments reported from Konigsberg Gas Works in 1904-5 showed the following yields of gas from New Levarson coal, in cubic feet per ton of dry coal:

Fresh from steamer	10,873 cu. ft.
After storing 2 months	10,815 cu. ft.
After storing 7 months	9,829 cu. ft.

"The falling off in 7 months in this case, therefore, amounted to 8.6 per cent.

"The diminution in value of the coke is a very important point in connection with the storage of coal. Storage of the coal reduces its coking qualities and so renders the resultant coke small and dusty. There is also a considerable decrease in the heating value.

"Most of the returns received from gas undertakings refer to Ruhr coals. According to the particular coal used, the diminution is reported to range from ½ to 6 per cent. on an average make of (say) 10,765 cubic feet per ton. This is when coal is stored under cover. After 2½ years storage, the make is reduced by 18.6 per cent. The loss is appreciably greater when the coal is stored in the open. The figures reported range from 2 to 15 per cent., according to the length of storage. In one case a 25 per cent. reduction was found after several years storage. The average falling off for Ruhr coals stored for 1 year is, if stored in sheds 2.1 per cent., and if in the open 5.4 per cent. Thus, there is a difference of 3.3 per cent. in favor of storage under cover. The results for Saar coal are tolerably concordant, and show an average loss of only 3.3 per cent. with storage in the open and of 1.6 per cent. with storage in sheds. Coals from Silesia and Saxony show an average loss of 4 per cent. With the latter it appears to matter little whether they are stored in the open or under cover.

"The following results obtained at the Breslau Gas Works, with coal from the 'Konigin Louise' mine (Silesia) are also interesting:

	Condition of coal		
	Fresh screened lump coal	Fresh but unscreened coal	Weathered through prolonged exposure
Ash in dry coal, per cent	4.22	5.12	6.07
Make of gas per ton cu. ft. at 60° F. and 30"	12,032	10,817	9,026
Gross calorific power of gas, B.t.u. per cu. ft	591	586	580
Yield, per cent. by weight—			
Coke: Large	93.28	86.06	52.73
Small	4.45	8.77	18.91
Breeze	2.27	5.17	28.36
Tar	5.94	4.77	4.75
Ammonia	0.309	0.191	0.252

"These figures show in particular the great decrease in the value of the coke caused by weathering of the coal."

In the discussion of the paper the deterioration of the coal after 15 months is quoted at 1.7 per cent. in the make of gas, with an increase of 10 to 11 per cent. in the fuel used in the producers.

EFFECT OF STORAGE OF A GERMAN COAL IN THE OPEN FOR TWO AND ONE-HALF YEARS.
(*Journal of Gas Lighting*, July 16, 1912, p. 190.)

	Fresh	Stored
Temperature of setting, degrees F	2,138	2,129
Period of carbonization, hours	4.5	4.5
Gas made per ton true coal, cu. ft. at 60° F. 30″ and saturated	13,127	13,762
Gross B.t.u. per cu. ft. at 60° F. 30″ and saturated	602	560
Calorific valuation figure, B.t.u. per ton	7,902,454	7,706,720
Specific gravity of gas	0.431	0.421
Ammonia, per cent. by weight of true coal	0.259	0.2945
Coke per cent., by weight of true coal	66.0	67.0

"The coal had not changed appreciably in chemical composition or calorific power by storage, and nearly the same calorific valuation figure was obtained on distillation. On the other hand, the stored coal afforded more gas of lower calorific power than the fresh coal, and the coke had fallen off in quality."

"The results of some experiments carried out on the coal-testing plant at the Saltly Gas Works of the Birmingham Corporation, by Mr. Davidson, (*Journal of Gas Lighting*, Sept. 3, 1912, p. 617) showed that the gas multiples for coals which had been stocked for periods of 6 months to 2 years were in every case lower. No definite loss per annum is fixed by the tests, but it would appear to be no more than 2 per cent. The experiments showed that while the gas value decreased the liquor increased very appreciably, but the coke was markedly inferior. The following figures are those given for a well known English gas coal which was tested after the intervals as stated:

	Moisture	Make per ton (cu. ft.)
On arrival	2.71	11,818
After 3 months	5.22	10,708
After 5 months	5.64	9,780
After 6 months	7.58	9,630
After 7 months	5.72	9,817

"The tendency for the moisture to decrease and for the gas yield to increase as shown by the bottom figures, is certainly remarkable, and it is difficult to offer any satisfactory explanation. It certainly has been suggested that deterioration goes on to a certain stage and then ceases, but the writer has never seen it stated that after this period is reached the coals begin to retrieve their losses. Probably in this case the difference can be put down to some undetected error in the test."

M. Winckler, from the use of four English coals, concludes that the average loss of volumetric yield at the end of the first month was from 1 to 1½ per cent., increasing from the second to the third month and possibly longer, though beyond a certain maximum, it would drop and approach zero. He asserts that by increasing the period of storage, coals lower their gas yielding power and light giving qualities also. (*Journal of Gas Lighting,* June 3, 1913, p. 662.)

Some later reports from across the water are here quoted as follows:

"At Mariendorf[1] they had found one kind of coal to give not a reduced quantity, but an impaired quality, of gas after some months storage. The quality of coke was also affected by the storage of the coal, its hardness being greatly reduced. Dr. K. Bunte, of Carlsruhe, laid stress upon the decrease in the quantity of large-sized coke induced by long storage of the coal,—46 per cent. instead of 66 per cent. of the whole coke after about 2½ years storage." (Heinitz coal.)

"The Carlsruhe Gas Research Station[2] has issued a report on a certain coal which has been set aside for an investigation of the problem of what difference it makes whether coal is stored in the open air or under cover. In February, 1910, the Dusseldorf Gas Works stored 150 tons of Konigsgrube coal in the open air to a depth of 11 feet 8 inches, and another 150 tons in a shed to a depth of 10 feet. In July and August, 1913, that is after 3½ years storage, 10 tons of each were sent to

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[1] Dr. Geipert, of Mariendorf, on English Coals, *Gas World*, November 18, 1911, p. 611.

[2] "Open Air Storage *vs.* Storage Under Cover—Results of Test," *Gas World*, May 23, 1914, p. 694.

Carlsruhe, and the two coals carbonized under exactly similar experimental conditions. The most important of the data obtained are the following:

	Coal stored in shed	Coal stored in open air
Composition of coal:		
Ash, per cent	10.61	11.11
Moisture, gross, per cent	0.21	5.46
Carbon, per cent	86.92	82.09
Carbonization data:		
Temperature of carbonization, degrees C.	1,185	1,180
Yield of gas at 15° C. and 760 mm. in cu. ft. per ton	11,792	11,792
Yield of coke, per cent	71.9	71.1
Yield of tar, per cent	3.8	4.4
Gross heating value of gas, B.t.u. per cu. ft.	592.7	589.9
Ammonia per ton, lbs	6.074	5.916
Coke data:		
Went through the sieve, per cent	19	32.2
The remainder, after a fall of 140 in., gave:		
Lumps above 1.8 in., per cent	48.0	34.5
Nuts 1.2 to 1.8 in., per cent	25.7	22.8
Beans and peas 0.2 to 1.2 in., per cent	19.3	31.3
Dust, per cent	7.0	11.3

"These data apply, of course, only to the particular kind of coal in question, but it is interesting to note that in this case the yield of gas and the heating value of the gas presented no marked difference, but that the coke made from coal stored in the open air was decidedly inferior to that stored under cover. In other respects the results were substantially the same."

In our own country there have been a number of extensive experiments on weathering and the spontaneous combustion of coals by the Bureau of Mines and by the University of Illinois. No reports are published covering the effect on the production of gas, coke, ammonia and tar.

Dr. Porter[8] tabulates results from a number of different coals. He states:

"The results show in the case of the New River coal a loss of less than 1 per cent. of calorific value in 1 year by weathering in the open. In 2 years the greatest loss was at Key West, and amounted to 1.85 per cent. There was practically no loss at all in the submerged samples in 1 year, fresh or salt water serving equally well to "preserve the virtues" of the coal. There was almost no slaking of lumps in the run-of-mine samples. In all tests the crushed coal deteriorated more rapidly than the run-of-mine.

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[8] "Deterioration and Spontaneous Heating of Coal in Storage," Technical Paper No. 16, Bureau of Mines.

"The Pocahontas run-of-mine coal in a 120-ton pile on the Isthmus of Panama lost, during 1 year's outdoor weathering, less than 0.4 per cent. of its heating value, and showed little slaking of lumps.

"Gas coals during 1 year's outdoor exposure suffered practically no loss of calorific value, measurable by the calorimetric method used, not even in the coal forming the top 6-inch layer in the bins."

Dr. Porter also writes in his lecture before the Department of Chemical Engineering, University of Pittsburgh, Nov. 9, 1914:

"Deterioration of coal in storage is due to slow oxidation, not to loss in volatile matter. The deterioration in heating value is not as great as has been commonly supposed. With high grade bituminous and semi-bituminous coals, careful determination has recently shown that this loss amounts to less than 1 per cent. in 1 year's exposure to the weather and less than 3 per cent. in 5 years. With our middle-western and western coals or lignites, the loss is greater, but probably does not exceed 4 or 5 per cent. in 1 year in any case. Deterioration in size or physical character may be somewhat more serious, and spontaneous heating, even though moderate in degree, causes very serious loss. Deterioration of any kind may be quite largely prevented by submergence storage under water."

In *Bulletin No. 38* of the University of Illinois, by S. W. Parr and W. F. Wheeler, entitled, "The Weathering of Coal," is given an historical view of various foreign and domestic investigators to the effect of storage on coals, together with reports of extensive experiments in the "change in weight" and "change in calorific value" of coals found in Illinois and nearby States, stored in piles in the open, in covered bins and under water. It also gives numerous references to previous reports. This *Bulletin* concludes with the following:

"Coal of the type found in Illinois and neighboring States is not affected seriously during storage when only the changes in weight and losses in heating power are considered. The changes in weight may be either gains or losses of probably never over 2 per cent. in a period of 1 year. The heating value decreases most rapidly during the first week after mining, and continues to decrease more and more slowly for an indefinite time. In the coals that have been tested, 1 per cent. is about the average loss for the first week, and 3 to 3½ per cent. would cover the losses for a year, although in some instances the loss was found to be as high as 5 per cent. in a year.

"The losses due to disintegration of the coal and to spontaneous ignition seem to be of far greater importance than any changes in weight and heating value, although they cannot be expressed in figures for comparison. The storage of coal of a size larger than is to be used would overcome part of this objection to storage, as the coal could be crushed to the most advantageous size just before firing. The larger sizes of coal are also much less liable to take fire spontaneously. Storage under water will prevent disintegration of the coal to a very large extent, and it will absolutely prevent any fire losses. Aside from these advantages in favor of storing coal under water, there seems to be very little to be said in favor of any particular method of storing coal."

E. F. Wilson, of the Westmoreland Coal Co., reports the results of experiments on lots of 25 to 50 tons of screened commercial lump coal as shipped to gas companies, as follows:

"We found, in the first place, a perceptible physical deterioration of the coal in open piles on the ground exposed to the weather manifested in a certain amount of breaking down of lumps due to frost, a loss of luster due to surface oxidation, discoloration from rain and the leaching out of soluble substances in the partings and crevices of lumps and their deposition upon the surface. All of these physical phenomena were confined chiefly to the outer layer of pile, being scarcely noticeable below a depth of 1½ feet from the surface. When it came to determining the extent of the deterioration by analysis or by carbonization tests we did not arrive at any definite figures. The difficulty of sampling lump coal closely enough to reliably reveal the extent of the slight changes taking place was too great. That is, the natural variations between samples were greater than changes in the coal.

"We later experimented in the same way upon ¾ inch slack and were able to determine a slight deterioration, since this material is an easier sampling proposition and also deteriorates to a greater extent than lump. In an uncovered pile on the ground we found a depreciation in B. t. u.'s per pound of combustible after 1 month of 0.50 per cent., 2 months 0.85 per cent., 3 months 0.95 per cent., 5 months 1.16 per cent., 6 months 1.11 per cent., 7 months 1.03 per cent., 8 months 1.16 per cent., 9 months 1.15 per cent., 10 months 1.13 per cent., 1 year 1.76 per cent., 1½ years 2.93 per cent., 2 years 2.81 per cent. It should be noted that this was originally a 50-ton conical pile. Constant digging in to get average samples once a month reduced the depth to an average of from 4 to 5 feet, constantly bringing to the surface fresh layers for oxidation, whereas if the pile had been left undisturbed the deterioration would have been confined chiefly to the surface. In other words, the conditions of test were extreme."

Bulletin No. 46, of the University of Illinois, on the "Spontaneous Combustion of Coal," by S. W. Parr and F. W. Kressmann, gives details of large numbers of investigations of the causes of spontaneous combustion and the precautions necessary to prevent same.

Technical Paper No. 65.—"A Study of the Oxidation of Coal," by H. C. Porter and O. C. Ralston, also treats of spontaneous combustion.

Dr. Porter, in *Technical Paper No. 16,* gives the following:

"Suggestions for Storing Coal.

1. Do not pile over 12 feet deep, nor so that any point in the interior of a pile will be over 10 feet from an air-cooled surface.
2. If possible, store only screened lump coal.
3. Keep out dust as much as possible; to this end reduce handling to a minimum.
4. Pile so that lump and fine are distributed as evenly as possible; not, as is often done, allowing lumps to roll down from the peak and form air passages at the bottom of the pile.
5. Rehandle and screen after 2 months if practicable.
6. Do not store near external sources of heat, even though the heat transmitted be moderate.
7. Allow 6 weeks' "seasoning" after mining and before storing.
8. Avoid alternate wetting and drying.
9. Avoid admission of air to interior of pile through interstices around foreign objects, such as timbers or irregular brickwork, or through porous bottoms, such as coarse cinders.
10. Do not try to ventilate by pipes, or more harm may often be done than good."

Conclusion.

From a study of the foregoing extracts, there seems to be no doubt that in the foreign coals there is some deterioration due to weathering. This is shown particularly in the loss of gas and in the quality of the coke. No definite results can be quoted on the tar or ammonia products. The loss starts at once, and is at a much more rapid rate at the beginning, but grows less as the period becomes longer. It should be remembered, however, that the figures quoted are for foreign coals which in many respects differ from our own. Any attempt to predict the behavior of an American coal from experiments based upon foreign coals should be undertaken with a full realization of this fact.

With American gas coals, exposure affects calorific value but little, whether stored under cover or in the open. No figures are given as to the direct loss in gas or in the quality of the coke or amount of tar and ammonia. Prof. White, of the University of Michigan, has had Pittsburgh and Fairmont coals under observation for four years, and reports no material loss in gas, but some loss of ammonia. (Report will be published at the end of the fifth year.)

The question of the method of storage of coal must be determined largely by the cost of handling or other local conditions rather than that of loss due to deterioration from weathering, although it is generally recognized that the storage of coal will injure the quality of the coke produced. In this connection, the difficulty of handling a frozen pile must be considered. Expensive coal storage sheds are warranted only in exceptional cases.

Sheds need be designed with capacity only large enough to care for the coal as it is used. Stock coal should be in lumps as large as possible, stored in the open and be used in case of emergency only. Thus, freshly mined coal would be continuously carbonized, and any loss due to weathering or handling from the open pile would be reduced to a minimum.

(C) COKE.

1. *Coke Requirements For Various Uses.*

The uses of coke may be classified into two general divisions:

For domestic use

For metallurgical use

and the requirement of these two divisions may be widely different.

Domestic Coke.—The domestic consumer requires a product which will give him the most heat for the least trouble and cost. House heating furnaces have in general, at least in the East, been designed for burning anthracite coal, and the consumer has received his training from childhood in the handling of hard coal fires. For this reason, the nearer coke for such use approaches the characteristics of anthracite coal, the more ready its sale. It would seem, however, that this is not necessarily so, and that through education, coke could be sold upon its merits as a fuel, irrespective of whether it approaches the characteristics of hard coal or not.

The main requirement of such a coke would seem, therefore, to be:

That it should be clean and free from breeze, and uniform in quality.

That it should be sufficiently tough to resist excessive breakage in handling.

That it should be of suitable size for the use to which it is to be put.

That the quantity of ash should be sufficiently low, and its fusing temperature sufficiently high, to prevent clinker troubles.

Metallurgical Coke.—The requirements of a coke for metallurgical purposes, on the other hand, are much more rigid and can be divided into two heads:

Chemical purity
Physical structure

It is well known that the carbonizing operation removes none of the impurities in the coal except a portion of the sulphur, and the amount of this element removed depends not upon the coking operation but upon the chemical combination in which the sulphur exists. Therefore, in order to control the chemical purity of the coke, it is necessary to select coal sufficiently pure to produce a coke of the required quality.

High ash in coke for use in blast furnaces is objectionable on account of the increased duty of fluxing the ash and the increased cinder volume which is met with when using the leaner ores. Sulphur is even more objectionable than ash if it exceeds a certain limit determined by the composition, the temperature and the volume of the slag. These are either fixed by the raw materials or chosen to produce a certain grade of iron. To eliminate sulphur as ordinarily present, it must be dissolved in the slag, which for a given composition and temperature has a fixed saturation point and can take care of only a limited amount.

The physical structure of the coke is quite as important as its chemical purity, and different physical structure is required for different purposes. Coke consists essentially of a mass of cells surrounded by cell walls, and the relation between the cells and the walls and the hardness of the wall structure determines the physical structure of the coke. In an average coke the volume of the cells is somewhat less than half of the total volume of the piece. A smaller proportion of cells makes a dense coke which burns slowly; conversely, a larger proportion of cells makes a light coke which burns more rapidly.

Different ores will require coke having a different rapidity of burning. In general, with a fast burning coke each molecule of oxygen in the air from the tuyeres immediately finds its molecule of carbon in the tuyere zone, and combustion takes place rapidly and with great intensity. By thus concentrating the combustion in a comparatively small area, the highest heat effect is produced. With slow burning coke, on the other hand, the molecules of oxygen are not all able to combine immediately with their molecules of carbon. The result is that combustion is carried higher up in the furnace, the heat generated by combustion is spread over a larger area, and the top temperature increases. The coke pieces being consumed but slowly, no rapid shrinking of the stock takes place such as characterizes a fast driving furnace with a highly heated combustion zone. Consequently, the blast pressures goes up, the furnace begins to hang, and good practice becomes impossible.

If, however, the coke is too soft and burns too rapidly, it is more readily dissolved by the CO_2 in the escaping gases. This, together with excessive abrasion, reduces it to a small size, favoring direct reduction of the cres by the coke rather than by the CO. This results in an increased consumption of fuel, accelerating the movement of the stock, and not sufficient coke reaches the tuyeres to maintain the temperature in the hearth. From this it will be seen that it is possible to have a coke which may be entirely too dense or too porous.

The quality of the wall structure also affects the coke value. A hard, metallic structure has always been considered the first requirement of a good furnace coke as indicating its ability to resist abrasion. The crushing effect of the charge by weight is comparatively small, but the abrasive treatment to which the coke is subjected in the handling, and more so in the furnace when it is simultaneously attacked by the gases, is severe, and unless the coke is hard, but not too brittle, and tough without being soft, it will go to pieces on its downward path in the furnace.

2. *Quality of Coke as Affected by Quality of Coal.*

There are three main factors which determine the quality of coke,—quality or composition of the coal, its preparation the method of coking.

Quality of Coal.—As has been pointed out, the impurities in the coal reappear in the coke, with the exception of a portion of the sulphur, so it is necessary to select a coal of sufficient purity to produce the desired coke. In many coals the chemical composition can be improved by washing, which removes a portion of the ash, sulphur and phosphorus. All of these impurities usually exist partially in the coal body, and partially separate from the coal in the form of slate, partings, sulphur balls, etc., and the extent to which the coal can be improved by washing depends much upon this point. A simple laboratory test will show what improvement ought to be made by washing the coal. A sample of coal is broken down sufficiently to separate most of the slatey matter from the coal, say to ¼-inch size and smaller, and the sample is then placed in a solution of calcium chloride or sulphuric acid of about 1.35 specific gravity, the exact specific gravity varying with the coal to be tested. In this solution, the purer coal floats, and the slate, pyrites, etc., fall to the bottom. An analysis of the floating material shows the quality of the coal that should be gotten in a perfect washing operation, and the amount of the floating material shows the percentage of clean coal that could be recovered. Of course, the results in commercial work are not as perfect as in the laboratory test.

While at present the washing of coal is confined mainly to coke oven practice, still, as the purer coals of the country are consumed, more and more will have to be washed.

Mixing of Coals.—The selection of a coal for carbonizing depends upon several variables. The gas man wants one which while producing the greater quantity of good gas, will at the same time turn out a coke suitable for the local market, as well as give a maximum yield of other residuals (such as tar and tar products, ammonia, cyanogen, etc.). The coke oven man on the other hand is more concerned about the quality of the coke produced than of the gas yield. Since, in general, a high volatile coal will not produce as tough a coke as will a lower volatile, the gas man who wishes to produce a metallurgical coke, or the coke oven man who wishes to produce an illuminating gas, must both accept some compromises.

No method has yet been discovered by which the coking quality of a coal can be determined from chemical analyses. In general, however, in a good coking coal the quantity of oxygen will be small and the ratio $\frac{H}{O}$ will be above 0.60. Oxygen appears to attack the resinous constituents, destroying their cementing properties, and it seems to be the oxidation taking place in stored coal which may cause it to lose some of its coking properties.

When all the metallurgical coke in the country was made in bee-hive ovens, it was customary to locate the ovens next to a coal mine which had been proved to produce coal suitable for making the coke required by the adjacent market. The famous Connellsville basin in America and the Durham coal in England, obtained their reputations on account of these coals being especially adapted to the methods employed in the bee-hive process. With the advent of the retort oven, which is usually located at or near the point of consumption of the coke, the practice arose of mixing two or more coals to produce a better coke than either would produce alone. By varying the percentages of high and low volatile coal, for example, material changes can be made in the relation of cell and wall volumes, and also in the hardness of the coke and other physical characteristics. This practice has made many coals available for producing marketable metallurgical coke which heretofore had not been regarded as standard coking coals. Sometimes three coals are mixed to advantage.

Fine Grinding.—In the bee-hive oven practice the coal was ordinarily charged into the ovens just as it came from the mines, but in retort oven practice it is generally customary to grind the coal so that from 60 to 90 per cent. will pass through a ⅛-inch screen. In many cases this grinding materially improves the physical structure of the coke. When two or more coals are used, or when any coal is irregular in quality, grinding serves to bring the particles of coal into intimate contact, thereby permitting them to act on each other to produce a uniform coke structure. Fine grinding also breaks up the pieces of slate, which would otherwise tend to break the coke, as the slate splits when suddenly cooled by the quenching water.

The practice of mixing and grinding coal to improve the quality of the coke is, insofar as known to your Committee, restricted to carbonization in ovens; in retort work, the incidental objections to the use of fine coal are such as to discourage its use.

3. *Method of Coking.*

Phenomenon of Coking.—When a coking gas coal is heated, it begins to melt at about 700° F., and thereafter solidifies at about 825° F. Up to this point there has been driven off about 50 per cent. by weight of the total volatile matter, this consisting chiefly of water and tarry oils together with about 0.4 cubic foot of gas per pound of coal containing considerable CO_2 and N. At a temperature of 825°, that material in the coal which causes coking and which we have called resinous matter, has been so altered in composition that it has lost its cementing properties; that is, if a coking coal which has once been heated to about 825° is crushed and again heated, no further cementing of these pieces will take place.

As stated earlier in the report, a high volatile coal will, in general, produce a poorer grade of coke than will a low volatile coal, although there are exceptions to this rule. A plausible theory for this is as follows:

The resinous matter, which apparently is that constituent of the coal which causes coking, contains a considerable quantity of volatile matter and upon heating, liberates gases and vapors so readily and in such large bubbles as to leave a very porous residue, which is soft and friable. Since this cementing material is in itself structurally weak, its function should be merely that of a binder to hold together the harder particles of carbon. On this basis, therefore, the strongest coke would be that containing the minimum cementing material consistent with a good bonding effect.

4. *Conclusions.*

In the appendices are given the results of laboratory and working scale tests upon coke which had been produced in various ways, and a study of these tests combined with information obtained through practical operation of retorts and ovens, leads to the following conclusions:

1. A coke for metallurgical purposes must be hard, but not too brittle, and tough without being soft; it must have neither too open a cell structure nor yet too dense. A coke suitable for one character of ore or one size of furnace, may not work well with another. It is evident, therefore, that it is very difficult, if not impossible, to specify the exact physical properties of coke, and the only sure method of determining its suitability for metallurgical use is by actual trial.

2. Since coke will tend to fracture along lines perpendicular to the heated surface of the coking chamber, it is evident that the size and shape of the coking chamber will affect the size

and shape of the coke. In circular vertical retorts, the cross-section of the coke will approach a sector of a circle, in ovens it will tend to be rectangular. For this reason a comparison of the toughness of coke produced in different systems of carbonizing by means of the shatter test may be misleading, unless the size of the original lumps is taken into account. It would seem that a fairer method of conducting such a comparative test would be to crush the original lumps to a uniform size and then measure the breakage occurring after the coke had been subjected to the specified treatment.

3. There is apparently no relation between the shatter test as usually conducted and the apparent specific gravity.

4. Fine coal will produce a coke of higher apparent specific gravity than will lump coal.

5. Slow carbonization will produce a coke of higher apparent specific gravity than will rapid carbonization.

6. Carbonization under a gas pressure of 20 pounds per square inch will produce a denser coke than carbonization at atmospheric pressure. This is possibly due to the smaller bubbles of gas formed under pressure.

7. Coal carbonized under a mechanical pressure of 20 pounds per square inch will give a denser coke than when carbonized under a gas pressure of 20 pounds per square inch. This may be due to the fact that while the gas bubbles may be of approximately the same size in both cases, the mechanical pressure forces together the plastic particles of coal into a more compact mass.

8. The greater the mechanical pressure under which coal is carbonized, the denser the coke produced.

9. Coke subjected to continuous heat after the volatile matter has been driven off, will shrink and increase in apparent specific gravity.

10. High heats produce large cells, harder cell walls, and smaller and more brittle coke than do low heats. This may in part be due to a shrinkage of the coke under high heats, and in part to excessive decomposition of the gas into carbon.

11. Low heats produce large, blocky pieces with relatively small cells and softer and tougher walls.

12. Fine coal produces larger coke than does lump coal. This may be explained by the fact that the more thoroughly the slate and other impurities are mixed with the coal, the less their tendency to split apart the lumps upon cooling. Also, the pasty particles of coal probably come into more intimate contact with each other when charged in fine lumps than when charged in large.

13. In general, a low volatile coal will produce a tougher coke than will a high volatile gas coal. (A possible theory to account for this is given above.)

14. The less completely carbonized the coal (that is, the more volatile matter contained in the coke), the lower the apparent specific gravity of the coke, and the poorer it withstands the shatter test.

15. The same coal carbonized in ovens will produce a tougher coke as determined by the shatter test than when carbonized in horizontal retorts. When the coal is carbonized inside of an iron box, whereby all mechanical pressure is relieved, the shatter test indicates the production of a tougher coke than that produced in horizontal retorts. In this case the difference is small, and, as stated above, the comparative tests may be misleading. From this, it would seem that any difference in the physical properties of the coke made in ovens and in horizontal retorts is probably due to the increased mechanical and gas pressures in the former. Since it was not possible to obtain comparative tests of coke from the same coal produced in ovens and in intermittent vertical retorts, it still leaves open the question as to whether such vertical retorts do or do not produce the same character of coke as do ovens.

16. If too much water is used in quenching, the steam formed in the pores of the coke disintegrates the surface, producing a surface covered with small black particles. By proper quenching methods the natural silvery luster of the coke can be retained.

APPENDIX "A."

To study the effect of size of coal, rapidity of carbonization, gas pressure and mechanical pressure during carbonization upon the quality of the coke produced, a series of laboratory experiments was made.

A West Virginia gas coal analyzing on a dry basis,—

Volatile combustible	39.4
Fixed carbon	53.8
Ash	6.8
	100.0
Sulphur	1.55

was crushed to two sizes, the lump coal to uniformly about ½ inch, and the fine coal to less than 1/16 inch, and carbonized in a 4-inch iron pipe placed in a muffle furnace, the depth of coal being about 4 inches.

During some of the tests, mechanical pressure was put upon the coal by means of a weighted plunger having a clearance between the walls of the pipe of less than ⅛ inch in the diameter. In this construction, pressure was maintained upon the carbonizing mass during the entire period.

In the gradual heating test, the muffle was brought up to a temperature of about 1,000° F. in from two to three hours, thereafter maintained at the maximum temperature of about 2,000° F. until the evolution of gas ceased, this latter requiring about two hours. In the rapid heating tests, the furnace was brought as rapidly as possible to the maximum temperature of about 2,000° F. (this requiring about one-half hour), and maintained at this temperature for about one and one-half hours, or until the evolution of gas had ceased.

It is interesting to note that in an attempt to obtain a gradual heating test using fine coal under mechanical pressure, the melted coal was squeezed out between the plunger and the walls of the pipe and carbonized in a spongy hollow cylinder above the plunger.

The apparent specific gravity of the coke was taken as an index of its quality the result of the tests being given in Table I and Fig. 1.

TABLE I.

	Fine coal			Lump coal		
	Apparent specific gravity		Per cent. volatile	Apparent specific gravity		Per cent. volatile
Character of carbonizing	Individual lumps	Average		Individual lumps	Average	
Rapid heating atmosphere pressure	0.71 0.74 0.71 0.76 0.77	0.73	1.1	0.73 0.74 0.70 0.70 0.70	0.71	1.3
Gradual heating atmosphere pressure	0.76 0.78 0.73 0.75 0.79	0.76	2.2	0.72 0.75 0.69 0.67 0.71	0.71	1.0
Rapid heating 20# per square inch gas pressure	0.93 0.81 0.69 0.70 0.71	0.77	0.07	0.71 0.78 0.64 0.74 0.80	0.74	0.8
Gradual heating 20# per square inch gas pressure	0.84 0.81 0.81 0.76 0.81	0.81	1.6	0.79 0.80 0.80 0.72 0.71	0.76	0.3
Rapid heating 20# per square inch mechanical pressure	0.93 0.83 0.87 0.88 0.83	0.87				
Rapid heating 50# per square inch mechanical pressure	1.07 1.03 1.19 1.01 0.90	1.04	1.6	0.79 0.85 0.79 0.81 0.83	0.81	1.3

Fourteen lumps of coke obtained as above from both fine and lump coal with both rapid and gradual heating at atmospheric pressure were subjected to further heating of from 2 to 4 hours, after which their apparent specific gravity was again determined. The average increase in apparent specific gravity was 15 per cent., and was due, it is believed, to the shrinking of the coke.

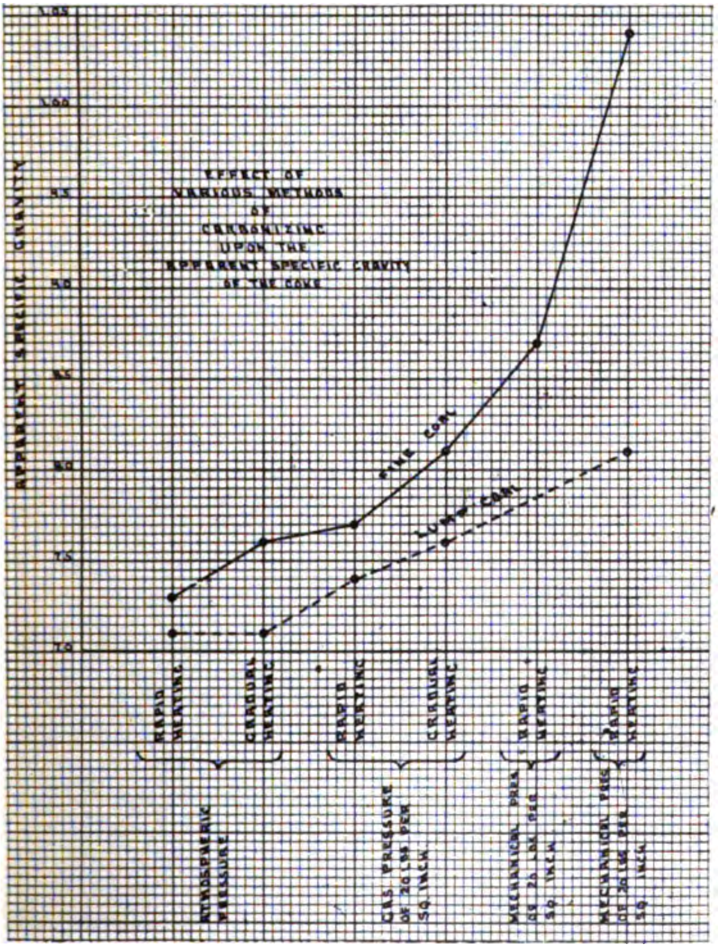

Fig. 1.—Method of Carbonizing. Page 27.

APPENDIX "B."

A series of tests was made at St. Louis in which various sizes of coal were carbonized for different periods in horizontal through retorts and in coke ovens.

The tests of coke were made to conform to the standard method in *Technical Paper No. 50,* Bureau of Mines; all coke was tested by the same corps of chemists so that the results should be strictly comparable.

The temperatures given are the average of the heating walls as determined by a Thwing pyrometer.

The coal analyzed as follows on a dry basis:

	Pocahontas	Elkhorn
Volatile matter	17.9	36.5
Fixed carbon	77.5	59.4
Ash	4.6	4.1
	100.0	100.0

The results of the tests are given in Table II.

The coke made from lump coal in the 16-foot retorts (which was carbonized in 8 hours at 1,900° F.) was smaller in size than that from the 20-foot retorts (which was carbonized in 12 hours at 1,700° F.), the former breaking up in finger-like pieces, while the latter was more irregular in shape and had more cross fractures. High heats seem to produce a smaller coke. When the coke ovens were being brought up to a uniform heat, it was very noticeable that any hot spot in the oven would produce very small coke; this fact has also been observed in retort practice and whenever the coke from retorts broke up into small pieces it was an indication that the temperatures were altogether too high.

TABLE II.

Carbonizing vessel	Kind of coal	Size of coal	Time carbonizing hours	Shatter test, per cent. on 2" screen	Specific gravity		Porosity	Yield of coke per cent.	Per cent. breeze	Per cent. vol.	Average temp. heating walls
					Apparent	Real					
20′ horizontal retort	Elkhorn	2" to ½"	12	34	0.845	1.865	54.7	64	—	1.1	1,700
	Elkhorn	1" & under	8	36	0.885	1.850	52.1	66	—	1.7	1,900
	Elkhorn	1" & under	12	39	0.892	1.844	51.6	62	—	1.4	1,910
	Elkhorn	½" & under	12	49	0.882	1.860	52.6	64	5.0	1.7	1,700
	Elkhorn, 65 per cent. Pocahontas, 35 per cent.	—	12	56	0.863	1.836	53.0	69	—	1.6	1,800
16′ horizontal retort	Elkhorn	2" to ½"	8	24	0.910	1.866	51.2	64	7.0	1.3	1,900
	Elkhorn	½" & under	8	42	0.994	1.874	47.0	—	5.1	2.1	1,900
	Elkhorn, 65 per cent. Pocahontas, 35 per cent.	—	8	43	0.872	1.890	54.0	66	7.5	1.3	1,900
	Elkhorn, 65 per cent. Pocahontas, 35 per cent.	—	24	52	0.953	1.950	51.0	67	—	1.0	1,900
Ovens 37′ by 10′ by 19′ and ¾"	Elkhorn	2" to ½"	22	49	0.978	1.858	47.4	—	—	0.9	1,800*
	Elkhorn	½" & under	22	46	0.929	1.808	48.6	—	—	0.7	1,800*
	Elkhorn, 65 per cent. Pocahontas, 35 per cent.	—	22	58	0.940	1.884	50.0	—	—	1.2	1,800*
	Elkhorn, 65 per cent.	—	48	87	0.995	1.866	46.7	—	—	1.8	1,400 to 1,600
	Pocahontas, 35 per cent.	—	45	79	0.993	1.902	47.7	—	—	1.8	
	Elkhorn, 60 per cent. Pocahontas, 40 per cent.	—	20	70	—	—	—	—	—	—	1,900

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* This coke was obtained from coal enclosed in a steel box placed on a wide 2-in. plank, and then pushed just inside the oven on the coke discharging side. The 2-in. board was allowed to remain under the box while the coal was being coked. The top of the box was perforated for the escape of gas, but allowed no pressure from the coal above. Fig. 2 is from a photograph of the box and of the coke made.

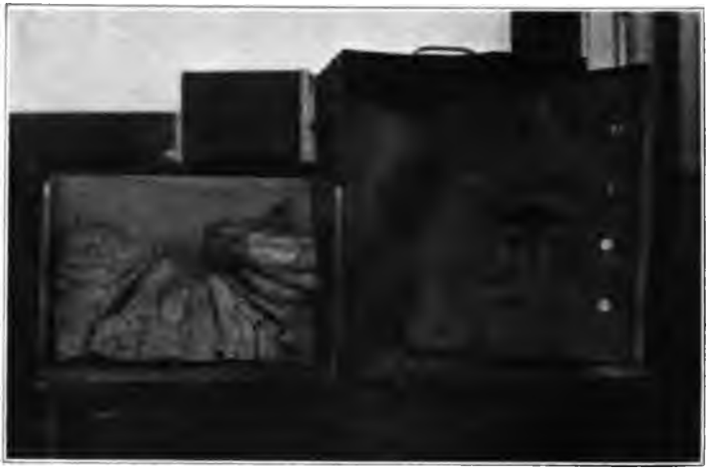


Fig. 2.—Coke carbonized inside of a box placed within a coke oven charge. Page 31.

APPENDIX "C."

COKING TESTS IN AN INTERMITTENT VERTICAL RETORT PLANT.

A series of tests was made using Westmoreland coal in a plant having intermittent vertical retorts, with a view to determining the effect on the resulting coke from variations in the following conditions:

1. Size of coal charged.
2. Carbonizing temperatures.
3. Length of carbonization period.
4. Method of quenching.

Unfortunately, such a short time was allowed the Committee to make these tests that only a few could be carried out, and it is very evident that a long series would be necessary to establish definitely any principles. However, the results are submitted below, and general conclusions have been drawn from them, in studying which the limited number of tests must be taken into account.

GENERAL CONCLUSIONS.

1. Because of the difficulty of preparing the coal, the number of tests using different sizes of grains between the limit of fine coal (averaging ¼ inch) and 6-inch lump, was limited to four.

The results obtained by the shatter and specific gravity tests do not seem to be conclusive. From this series alone, therefore, no deduction can safely be drawn as to the effect of size of coal upon the strength of the coke.

2. The volatile content of the coke decreased and the resistance to breakage, apparent and true specific gravities increased as the period of carbonization was lengthened. No definite relations could be determined between any of these characteristics from the limited data obtained.

3. As the carbonizing temperature was dropped and the period lengthened, the coke became larger in size and weaker in structure.

4. If too much water is used in quenching, the steam formed in the pores of the coke disintegrates the surface, producing a surface covered with small black particles. By proper quenching methods, the natural silvery luster of coke can be retained.

Methods of Conducting Tests.—As nearly as possible the same method of handling the coke was followed in all tests. It was dropped from the retort into a hot coke buggy and conveyed to a concrete platform just outside the retort house, where it was spread out and quenched with water from a hose. A representative sample was picked out by hand, an effort being made to get typical pieces from all parts of the charge.

The shatter test and the method used for obtaining its apparent specific gravity are as described in *Technical Paper No. 50,* of the Bureau of Mines. The method of obtaining the true specific gravity is a modification of that described under "Ordinary method" in *Technical Paper No. 8* by the Bureau of Mines, a pycnometer with a long capillary tube stopper being used instead of a short stoppered pycnometer with a 6-inch drying tube.

For the shatter test, an average sample of 50 pounds was taken from the larger sample mentioned above, care being taken that no piece was smaller than two inches. This was dropped four times a distance of six feet on to iron plates, the entire sample being returned each time. After the fourth drop, the coke was passed over a 2-inch screen and the coarse and fine lots weighed, the result being expressed in the percentage of the entire sample that would not pass through the screen. The apparatus is shown in Fig. 3.

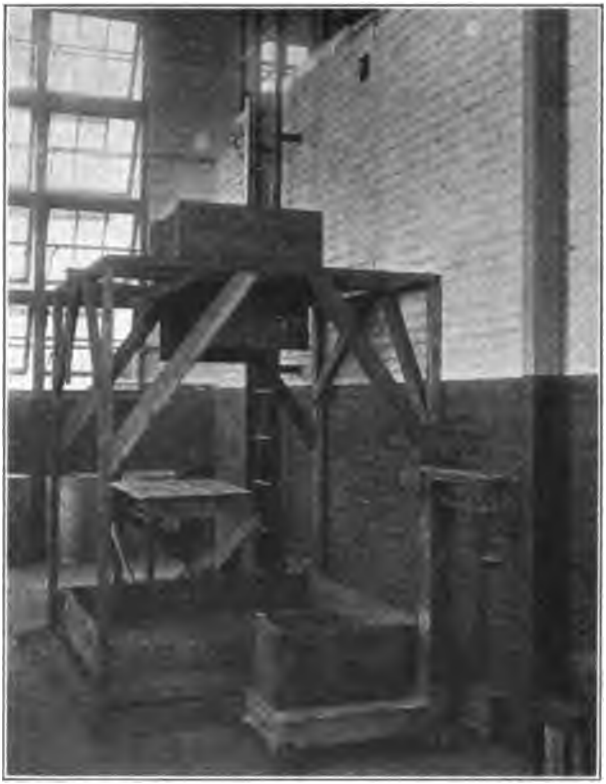


Fig. 3.—Shatter test apparatus. Page 34.

In general, duplicate shatter tests were made on all samples of coke where the amount of the sample permitted it. Duplicate and often triplicate tests were made to determine the apparent gravity for which 500 grams from coke used in the shatter tests were taken. In these two tests much depends upon the ability of the operator to select an average sample, and with the wide variation in the quality of the coke from different parts of the retort, this is a difficult matter. The shatter test is undoubtedly influenced by the previous treatment of the coke and the size and weight of the individual pieces. The extreme size of the coke from tests Nos. 14, 15 and 16 made it hard to select average samples, and the pieces were so large and heavy that the impact shattered them badly, there being no smaller pieces to cushion them until the second and third drop. In all cases care was taken to avoid excess water in quenching the coke and to have the coke as dry as possible. For the tests of apparent specific gravity, etc., the coke was dried out in the laboratory.

The temperatures marked "bottom" were taken in the combustion chamber (the hottest part of the setting), by a Wanner pyrometer and top temperatures were taken at a point where gases pass into the recuperator, by a Brown electric pyrometer. The temperatures marked "average" were averages of these and several others taken at six different points in the height of the retort.

Discussion of the Tests.—Series A, including tests Nos. 1, 2, 4 and 5, were made to determine the effect on the coke of charging different sizes of coal. Comparison of Nos. 1 and 2 indicates that coke from small size coal is stronger than from larger. Tests Nos. 4 and 5 apparently contradict this result, although this may be explained by the higher percentage of volatile left in No. 5 coke, showing the charge was not as well burned off as No. 4.

To check this further, tests shown under Series B were made, in which six retorts in the same bench were charged, three with coal as normally received and three with the coal

TABLE III.—SUMMARY OF COKE TESTS.

No. test	Size of coal	Carb. period (hours)	Temperature (degrees F.)			Per cent. volatile in coke	Per cent. 2" and over remaining on screen in shatter test	Appearance of coke	Apparent sp. gr.	True sp. gr.	Per cent. by vol. coke sub.	Per cent. by vol. cell spaces	Remarks
			Average	Top	Bottom								
	Series A (variations in size of coal)												
1	Coarse, clean ½" to 3". Average 1½".	13	1,980	1,340	2,350	5.37	50	Close grain, hard and firm, much cross fracture.	1.086	1.910	56.9	43.1	
2	Fine screenings, dust to ¾". Average ¼".	14	1,974	1,380	2,380	4.98	66	Like No. 1, slightly more porous.	1.008	1.907	52.8	47.2	
4	Lump, 4" to 6".	13½	2,060	1,315	2,380	6.04	61	Coke in tests 4 and 5 similar; No. 4 contained possibly more black butts.	1.096	1.887	58.1	41.9	Selected lumps of coal used.
5	Same as No. 4 pulverized. Average ¼".	13½	—	1,320	2,380	7.25	46		1.050	1.7953	58.5	41.5	Part of above crushed to ¼"
	Series B (variations in size and carbonizing period)												
17	Coarse	14	2,020	1,400	2,285	4.44	59	Normal	1.070	1.873	57.1	42.9	
18	Fine	14	2,020	1,400	2,285	5.00	51	Coke was green	1.026	1.857	55.3	44.7	Not well burned off.
19	Coarse	16	2,020	1,400	2,285	3.41	52	Normal	1.041	1.901	54.8	45.2	
20	Fine	16	2,020	1,400	2,285	3.61	50	Slightly green	1.114	1.887	59.0	41.0	
21	Coarse	18	2,020	1,400	2,285	2.79	52	Normal	1.071	1.894	56.6	43.4	
22	Fine	18	2,020	1,400	2,285	2.97	53	Normal	1.051	1.917	54.8	45.2	
	Series C (variations in carbonizing period)												
6	Size normally charged. No dust, average ¾".	12	2,137	1,450	2,400	6.02	52	Normal	1.017	1.7949	56.7	43.3	
7	Size normally charged. No dust, average ¾".	13	2,137	1,450	2,400	5.72	52	Normal	1.033	1.879	55.0	45.0	
8	Size normally charged. No dust, average ¾".	14	2,137	1,450	2,400	3.43	60	Normal	1.078	1.8890	57.1	42.9	
9	Size normally charged. No dust, average ¾".	15	2,137	1,450	2,400	3.74	59	Normal	1.100	1.8834	58.4	41.6	

TABLE III.—SUMMARY OF COKE TESTS.—(*Continued.*)

No. test	Size of coal	Carb. period (hours)	Temperature (degrees F.)			Per cent. volatile in coke	Per cent. 2″ and over remaining on screen in shatter test	Appearance of coke	Apparent sp. gr.	True sp. gr.	Per cent. by vol. coke sub.	Per cent. by vol. cell spaces	Remarks
			Average	Top	Bottom								
	Series D (variations in period with slightly lower temperature)												
10	Size normally charged. No dust, average ¾″.	12		1,430	2,350	8.94	51	Coke was green	1.004	1.7402	57.6	42.4	Coke not well burned off.
11	Size normally charged. No dust, average ¾″.	15		1,430	2,350	4.11	61	Normal	1.040	1.8407	56.5	43.5	
	Series E (temperature slightly lower than D)												
12	Same as No. 6 to No. 11 plus a little more fines.	12		1,340	2,350	10.16	53	Coke was green	0.996	1.693	58.8	41.2	
13	Same as No. 6 to No. 11 plus a little more fines.	15		1,340	2,350	5.52	57	Normal	1.044	1.831	57.0	43.0	
	Series F												
14	Normal size	22			1,900	10.13	40	Rather green	0.933	1.675	55.7	44.3	
15	Normal size	24			1,900	7.76	47	Coke in all three tests large in size; some 12″ lumps and many 8 to 9″ pieces.	0.950	1.755	54.2	45.8	
16	Normal size	26			1,900	5.59	54		1.010	1.863	54.2	45.8	
	Series G (quenching tests on coke from No. 1 test)												
23	Coke immersed in water. Coke blackened to depth of ½″ to 1″; surface covered with small black particles, dead sound.												
24	Coke dry cooled. Coke had bright steel gray lustre and sharp metallic ring.												
25	Coke steamed. Coke similar in appearance to dry cooled coke.												
26	Coke smothered in sand. As above.												

crushed to ¾ inch and less. One retort of each kind was dropped in 14 hours, another pair in 16 hours, and another in 18 hours.

Practically no distinction could be made between the coke made from coarse or fine coal when carbonized for the same length of time, greater variations in appearance occurring in coke from different parts of one retort than between specimens from the two retorts of each pair. While it would require many more tests to definitely establish the principle, seemingly, crushing the coal to ¾ inch and less, does not produce any marked effect on the coke.

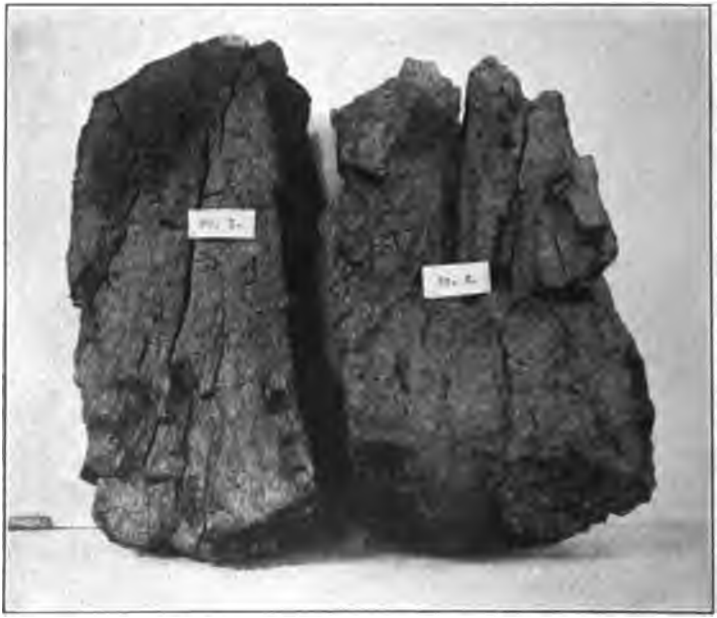


Fig. 4.—No. 1. Westmoreland coal pulverized to ¾ inch and under, carbonized for 18 hours. No. 2. Westmoreland coal 1¼ inch average size, carbonized for 18 hours. Page 41.

To determine the effect of different carbonization periods, Series C, including tests Nos. 6, 7, 8 and 9, was undertaken, in which the coal, of the usually charged size and free from dust, was carbonized for 12, 13, 14 and 15 hours in four different retorts. The results indicate that the longer distillation periods reduce the volatile content of the coke, increase its apparent and true specific gravity and also its resistance to breakage. Tests Nos. 10 and 11 of Series D, and Nos. 12 and 13 of Series E give the same results, although run at slightly lower temperatures.

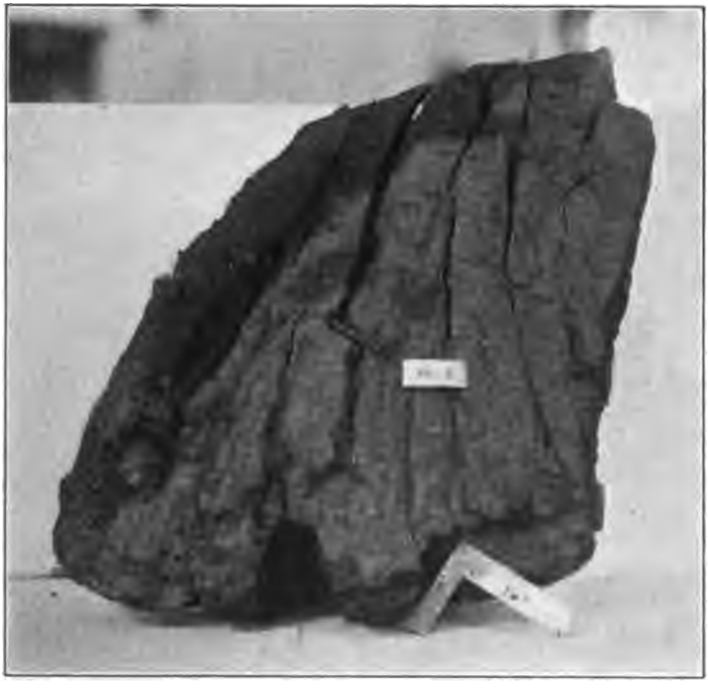


Fig. 5.—Westmoreland coal 1¼ inch, carbonized for 26 hours. Page 41.

It was hoped that some definite relation between the different characteristics of the coke from these tests could be established, but only the true specific gravity and the volatile showed any definite continuous relation, and this is undoubtedly influenced by the character of the sample.

In order to continue further the experiments to show the effect of low temperatures on the coke, Series F, including tests Nos. 14, 15 and 16, was run off, in which coal of usual size was carbonized for 22, 24 and 26 hours at temperatures from 400° to 500° lower than normal. The resulting coke was of unusually large size and porous as compared with the normal size coke produced at the plant. The 22-hour charge came out rather green, and while the 24-hour charge appeared well burned off, not until the coke had been carbonized for 26 hours, or practically twice the ordinary period, did the strength appear to be normal. As the temperature at which this test was carried on is too low to be practical in ordinary operation, it would appear that the size of coke is determined by the size of retort or oven in which it is carbonized, and that it cannot be changed to any marked extent by variations in methods of operation.

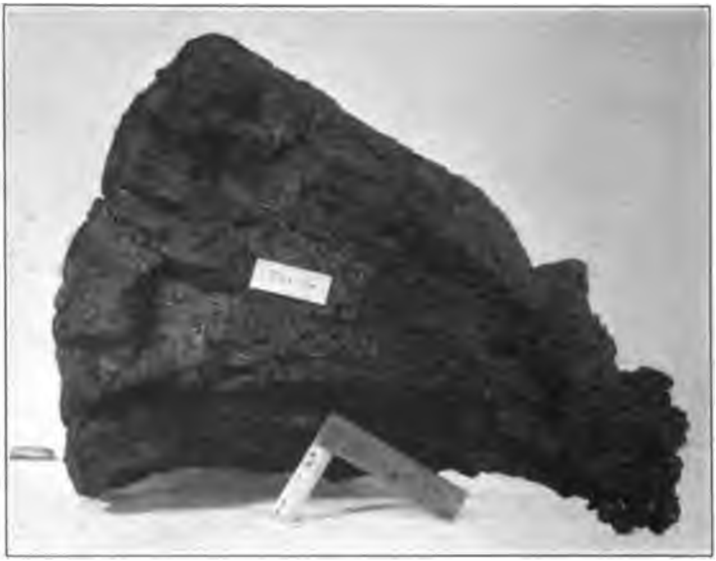


Fig. 6.—Westmoreland coal 1¼ inch, carbonized for 22 hours. Page 41.

Photographs of the coke produced in some of the above described tests are shown in Figs. 4, 5, 6 and 7.

Quenching Tests.—Four methods of quenching were tried:

1. Immersion in water, producing black discoloration which penetrated a considerable distance into coke.

2. Dry cooling, in which the coke enclosed in an air and water tight can is plunged into water to cool.

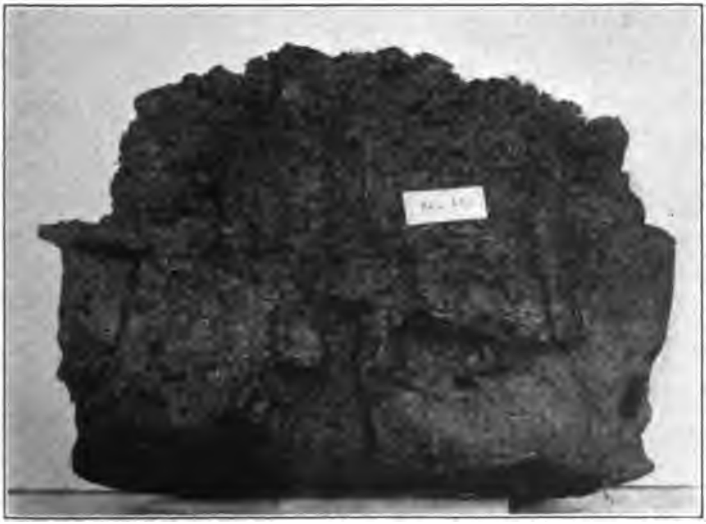


Fig. 7.—Westmoreland coal 1¼ inch, carbonized 24 hours. Piece from upper part of retort showing honeycomb structure. Page 41.

3. Steaming by means of putting a small amount of water in can and dumping in red hot coke.

4. Dry quenching by smothering in sand.

Apparently, by the latter three methods, the natural color of the coke is retained, and by none of them were the cross fractures increased.

An attempt was made to compare the coke made from Westmoreland coal in other types of retorts with that from intermittent verticals, but it was found that the difficulty of collecting a comparative sample and damage done to the coke in shipment, made the comparisons worthless.

O. B. Evans, *Chairman,*
W. H. Blauvelt,
C. W. Hunter,
Donald MacArthur,
H. K. Morrison,
O. A. Sinsel.

Mr. C. W. Hunter (Boston): (Written discussion communicated.) While most of the figures given in the report, on the subject of the loss of gas and deterioration of quality of coke caused by outside storage of gas coal, have been gathered from European sources, other data which I have seen seem to indicate that with American coals, a similar loss is possible. Apparently the greater part of the deterioration occurs in the first few months, and after six months or so, very little is noticeable. Depreciation of the coal starts as soon as it is mined, so that some loss occurs before the coal is received, over which the gas company has no control. While the different conditions obtaining in the various plants throughout the country make it necessary to know local conditions before designing a storage plant for any particular place, it would seem logical that each company should figure out what amount of coal is required as a reserve in case of emergency, such as strikes, delays in delivery, etc., and should put this amount in an emergency storage pile not to be touched except when the conditions arise for which it has been set aside. Usually, the investment made in the storing and reclaiming plant for this part of the total coal supply can be limited, as, except in the case of fires, it will not frequently have to be moved.

Deliveries of coal for the regular daily operation of the plant should be arranged, so that the coal can be used as soon after its arrival as possible. Where such deliveries are not made every day or two (as in the smaller plants receiving by water in large barges) and the coal has to remain outside of the retort house for some time before being used, an enclosed storage of sufficient size to contain the excess, would in many cases be found to be profitable. The plant will thus, at a minimum investment cost for storage, run a large percentage of the time on coal which has not been exposed to the air after delivery. Besides reducing losses in gas and coke, the storage bin will reduce risk of fire in the coal used for daily operation, will facilitate its handling in cold weather and can be frequently worked into the design of the coal handling system so as to materially reduce operating cost.

In looking over the experiments for the variations of strength of coke caused by variations in the size of the coal charged, it would seem from the tests in the horizontal retorts that the smaller the size of coal charged, the harder the coke obtained. In ten tests made in the intermittent verticals with various sizes of coals, however, the results obtained were so variable that we could establish no principle on this subject. Apparently to obtain the hardest coke of the larger sizes, long-time carbonization at reduced temperatures, with a high temperature at the finish, will produce the best results as far as the coke is concerned, but it would appear that other conditions would make this kind of operation out of the question for most companies.

On the question of the purchasing of gas coal on specification, it will probably be found that most gas companies will have considerable difficulty in getting the coal companies to bid on this basis. It would seem that this is a place where the Institute could render valuable service by appointing a committee to get up specifications and to talk with the coal companies on the subject in a manner similar to the conferences between the Institute Committee on Cast Iron Pipe Standards, and the foundries.

MR. W. F. LAWRENCE (Astoria, Long Island, N. Y.): (Written discussion communicated.) From observation of the very general use of bar screens, it is my opinion that this style of screen may be made to remove completely the slack if properly used. It is customary to have two screens, each approximately 6 by 14 feet, and placed one above the other; that with the bars 1½ inches apart being, of course, above the second screen, with the bars ¾ inch apart.

It can be readily seen that if coal is passed at too high a rate of speed over screens arranged in this manner, the slack will not be removed. Several factors enter into this: The size of mine cars, the time taken to dump each car onto the screens. the angle at which the screens are set, as well as their dimensions, which in most cases are fixed as stated above.

It was noticed that some of the companies were taking a great deal more care for the complete removal of the slack than others, thus producing a cleaner quality of screened coal, but in consequence, their percentage of slack removed for a period of years was higher than the average for the district, but in order to do this, they were careful that each of the several factors entering into the proper screening of the coal by means of bar screens were adjusted to suit the conditions of the coal being handled.

MR. CARROLL MILLER (Aurora, Ill.): (Written discussion communicated.) With regard to shortage of coal shipments, I think that in any event the coal should be weighed on its receipt, regardless of how, or by what route it is shipped. However, I have found that with coal received both by barge and cars, the weights usually check very closely with the invoices.

It is a very easy matter to weigh coal received in cars, but it is much more difficult to weigh it from barges, particularly when the latter are unloaded with a man trolley bridge. The coal handling system may allow the coal to be weighed after it is dumped from the bucket, but if it does not, the coal must be weighed in the bucket, and the only system which I know of that allows this, is one that necessitates the trolley passing over the scales at a time when the bucket is being neither raised nor lowered. This method necessarily causes some little loss in time. There is no trouble to weigh the coal automatically when passing over a belt.

It is desirable to buy coal on specification, but the greatest difficulty is in getting a fair sample. It is next to impossible to get a fair sample of lump coal, unless a large proportion of the coal as received is taken for a sample, and this necessarily means considerable expense. A fair sample can be obtained from a belt, after the coal has gone through the breaker, but this does not mean a sample of the cargo when part of it has gone to stock. Therefore, before the specifications are drawn up, to my mind, the principal points to consider will be the methods of sampling.

I described at the St. Louis meeting of the American Gas Institute, a method of sampling which was used in Providence, and I do not know of a better one, but it does not take a fair sample of a whole cargo unless all the coal goes to the retort house.

With regard to the storage of coal, I hesitate to discuss the subject of deterioration in storage, because I have no definite figures, and can only speak generally. In my experience, however, I have not been able to notice any deterioration, either in the coking qualities or in the amount of gas produced after the coal has been in stock a few weeks. Freshly mined coal seems to give better results than that which has been in stock a few weeks.

The examples cited in this report are practically all in connection with foreign coals, which, of course, differ greatly from our coals, and I think, therefore, that we cannot draw fair conclusions from them in regard to the storage of our own coals.

It has been often stated that the content of sulphur has an effect upon the spontaneous combustion, but I did not notice that this constituent has been mentioned in the report.

In my experience with high volatile coals, stored both under cover and outside, I have had to deal with but two fires caused by spontaneous combustion, both of which were in the coal stored under cover. The first one was in a wooden shed, and the coal stored something over 20 feet deep. The other was in a steel and concrete shed, where the coal was only a few feet deep. In the first case, I am positive that the fire started in a lot of wet coal which had been put into the shed. In the latter case, it appeared to be due to a piece of oily waste, which was at the bottom of the pile getting afire spontaneously, and igniting the coal. If the coal had been in the open, rain would possibly have kept the waste from becoming ignited. In the coal stored in the open to a depth of from 20 to 40 feet, I have seen no trouble with gas coal heating, but have recently heard of a rather serious fire in a pile of Pocahontas slack, which, as we know, is much more liable to spontaneous combustion than gas coal.

I cite the above, because these cases, with others that I know of, seem to prove that storing coal under cover will not prevent spontaneous combustion or deterioration of quality unless the coal is put into storage dry. When it is put into covered storage wet, I think there is more danger from spontaneous combustion than storing it in the open.

Rain will penetrate a pile of slack only a few feet. Therefore, if it goes into open storage dry, I do not think that there is any danger of spontaneous combustion or deterioration. In the case of mine run coal, there is probably enough dust and small coal to prevent the water penetrating to any great depth. Therefore, the above remarks apply to this size coal, and it would also appear that if my reasoning is true, it is much better to store coal in deep piles.

In some seams of coal, slack is purer than lump coal, this depending on the form in which the impurities appear in the seams.

Referring to the use of domestic coke, it must be thoroughly demonstrated to a new user, or he will go back to coal. A statement is made in the report that the nearer coke for domestic use approaches the characteristics of anthracite, the more ready its sale. I do not think that this is true, as I have found that when a consumer has used coke for a while, that he will not return to coal, because he prefers the performance of coke in his furnace.

The statement is made: "From this, it would seem that any difference in the physical properties of the coke made in ovens and in horizontal retorts is probably due to the increased mechanical and gas pressure in the former." I do not think that this can be true because the gas pressure in the ovens is practically the same as in retorts as ordinarily run, and the small physical pressure at the bottom of the ovens has no apparent effect, the quality of the coke at the bottom being practically the same as that at the top of the charge, where there is the same physical pressure as in a horizontal retort.

Aside from the percentage of pulverization and mixtures of coals, the greater density of coke made in a by-product oven is no doubt due to the long time of carbonization, and the shape of the carbonizing chamber, which latter causes the coal to run together when it melts. The same line of reasoning applies to vertical retorts and bee-hive ovens. It will be observed that the present practice of filling a horizontal retort almost full and carbonizing the charge for a longer period, produces a much denser coke than that formerly made in a retort with a light charge and short time of carbonization.

The coke produced in the Providence vertical retorts from a high volatile coal, ten hour charges, was tried in a cupola, and found to be satisfactory chemically and physically, except it was too small. It was impossible to make larger coke in retorts of that size and shape, at least, with the same kind and size of coal.

Mr. J. W. Shaeffer (Milwaukee): (Written discussion communicated.) In the matter of losses, due to weathering of coal, my experience coincides with the opinion of Dr. H. C. Porter and of Messrs. S. W. Parr and W. F. Wheeler, who state that losses due to spontaneous heating are far more serious than other changes due to ordinary weathering. At the plant of the Milwaukee Coke & Gas Company, both high and low volatile coal is stored in a semi-circular field to a maximum depth of 60 to 65 feet. No attempt is made to separate the fine and the coarse coal, although a small portion of the lump is screened out and sold as lump coal. The entire tonnage consumed for the year is brought in by boat during the navigation season, which generally begins in the latter part of April and closes December 1st. We aim to have only enough coal in stock at the close of navigation to last until the opening of navigation the following spring, with a sufficient margin of safety. This means that we have a stock of 400,000 tons, of which about 250,000 tons is in one pile and 150,000 tons in another. In early spring, we are, therefore, charging into our ovens, coal which has been stored in very large piles, six to eight months and exposed to all kinds of weather.

Up to a few years ago, we experienced considerable trouble with spontaneous heating, but for the past four seasons we have had practically no trouble in that respect. We attribute this largely to the fact that we increased the height of the bulkheads to about 25 feet and adopted the practice of plastering up all the interstices in the bulkheads, thus making a practically air-tight retaining wall. The pile is watched very closely for signs of incipient heating, the foreman in charge of the coal handling department making two trips daily over the piles. A warm spot is readily detected by the peculiar odor of heated coal, which may be likened to that of a blown-out kerosene lamp. Whenever such an odor is noticed, that part of the pile is immediately dug open and the warm coal removed.

One of the most important results from our viewpoint of stopping spontaneous heating, is the improvement in the quality of coke made from the old coal. There is no apparent difference between the quality of coke made from our fresh coal eight months old, so long as the latter has not been heated. We do find, however, that the gas yield from the older coal is somewhat lower than from the fresh coal, even when no heating has taken place. This loss of gas is increased decidedly by spontaneous heating. This will be shown clearly by Table I, which gives the monthly average gas yields and total British thermal heat units in the gas for the years 1912 and

1914, calculated to percentages of each respective year's average yields.

TABLE I.

	1912		1914	
	Gas yield	Total B. t. u.	Gas yield	Total B. t. u.
January	103.5	101.0	100.1	99.9
February	100.1	99.3	98.9	99.1
March	98.9	97.5	98.3	98.2
April	97.7	97.4	99.3	98.8
May	96.3	95.7	97.9	98.9
June	101.5	102.9	99.7	99.6
July	97.2	100.4	100.7	102.8
August	97.8	99.6	100.1	100.6
September	100.5	102.4	98.1	101.0
October	102.9	102.4	101.4	100.9
November	100.9	98.8	102.1	100.8
December	103.1	102.2	102.0	100.0

During the winter and spring of 1912, we had considerable trouble with spontaneous heating of the coal, while in 1914, we had practically no heating. It will be noted that the first few months of the year show lower yields in each case than the latter half of the year, but that this was more pronounced in 1912 than in 1914. Some old coal is charged in May and June, but from the latter part of June on, practically all new coal is used.

Table II shows the monthly average ammonia yields for the years 1912 and 1914, calculated to percentages of each respective year's average yields.

TABLE II.

	Ammonia 1912	Yield 1914
January	104.3	98.2
February	103.4	99.5
March	102.0	100.5
April	101.6	100.9
May	99.3	103.2
June	103.8	101.8
July	101.2	99.5
August	98.4	95.4
September	96.1	95.4
October	97.5	100.5
November	94.7	102.7
December	94.9	102.7

For the first six months of 1912, the ammonia yield was considerably higher than for the last six months of the year, while in 1914, the first six months showed only a very slightly higher yield than the last six months. From these figures, it might appear that coal which has suffered spontaneous heating has a tendency to give higher ammonia yields. These figures should not be taken as conclusive, however, as other considerations affect the ammonia yield. Our tar yields show no apparent relation to the age of the coal.

CHAIRMAN FORSTALL: We now have the report of the Committee on Chemical Tests.

REPORT OF THE COMMITTEE ON CHEMICAL TESTS.

In view of the fact that it is proposed to publish the result of the Committee's work as a gas chemist's handbook, and that the matter contained therein cannot be readily abstracted and is too voluminous to present in its entirety, the Committee wishes now to merely outline the nature of the work upon which it has been engaged, and which will be represented in its final form in the handbook to be published early in the coming year.

In order that the whole field of gas testing, as well as the field of testing in collateral lines, might be fully covered, a committee was selected with this object in view, and the work was subdivided among the members of the committee in such a manner that the various chapters were compiled by men who had special training and information concerning the subject about which they wrote. In this way, the Committee feels that it has embodied in the handbook, if not in every instance, an entirely satisfactory method of analysis, at least the best information obtainable at the present time and state of the art concerning the test, and that the work can be safely used not only as a laboratory manual in companies carrying out their own chemical work, but also in connection with the purchase of raw material used in the gas business. It is believed that in the majority of cases, those who supply the gas companies will consider these methods as possessing not only the necessary scientific accuracy, but as giving results which will be fair to both the purchaser and the seller.

In most cases, preference has been given to the method of analysis giving the highest degree of accuracy, irrespective of the time necessary in carrying out the test, but alternate methods giving results of sufficient accuracy to meet ordinary works conditions have also been included. These are intended to be used where extreme accuracy can be subordinated to the saving of a considerable amount of time.

The Committee does not wish it to be understood that it considers the methods beyond criticism, but it has used its utmost endeavors to obtain the best methods, and in view of the wide experience and varied connections of the various members of the Committee, we feel that in most cases the desired result has been attained.

A great deal of care and time have been expended in properly indexing the book and in preparing a useful bibliography, but an attempt has been made to give full information in the book itself for carrying out the various tests without the necessity for referring to other literature which may be difficult to obtain. A few exceptions, however, have been made to this where the Committee has adopted in their entirety methods recommended by other technical societies which have been published and are generally available. This applies particularly to the testing of materials not frequently encountered in the routine of the gas works chemist, such as the testing of iron, steel, cement, lubricating oils, etc.

While recognizing the value of tables of constants and of other tables of useful information having a more or less direct bearing on the work of the gas works chemist, the Committee has included in the handbook only such tables as are most frequently used, for the reason that there are many published volumes such as Castell-Evans Physico-Chemical Tables, The Chemiker Kalander and others, which give complete information in comprehensive and readily available form, and it is felt that one or more of such books always will be found in the library of even the smallest chemical laboratory.

The Chairman wishes to express to the members who compiled the various chapters his appreciation for their untiring efforts on behalf of the Committee's work, and he feels that the Institute is especially indebted to those companies who, though not directly engaged in the business of manufacturing gas, have contributed to the work of the Chemical Tests Committee, their representatives joining the Institute in order that they might serve on the Committee.

C. C. TUTWILER, *Chairman,*
A. P. BEARDSLEY,
S. R. CHURCH,
W. H. FULWEILER,
R. G. GRISWOLD,
C. E. LEWARS,
J. M. MOREHEAD,
C. J. RAMSBURG,
E. C. UHLIG,
A. B. WAY,
A. H. WHITE.

CHAIRMAN FORSTALL: We will next consider the report of the Committee on Classification of Gas Engineering.

REPORT OF THE COMMITTEE ON CLASSIFICATION OF GAS ENGINEERING.

Your Committee decided that inasmuch as there is nearly as great a demand in other lines of engineering for a suitable classification, that its first effort should be put forth toward obtaining the co-operation of other engineering societies toward the compilation of a complete classification system.

In response to our invitation, representatives from six national engineering societies, and two especially qualified librarians, met in New York for a preliminary discussion of this subject. The discussion revealed a unanimity of opinion that the work would be of great value to members of technical associations and others, and that co-operation could be readily obtained from all associations.

At a later meeting, delegates from twenty national, technical and scientific societies met in the United Engineering Societies Building, New York, and perfected a permanent organization, the purpose of which was declared to be to prepare a classification of the literature of applied science which might be generally accepted and adopted by these and other organizations.

The name adopted for this organization is "Joint Committee on Classification of Technical Literature."

Permanent organization was effected by the election of the following officers:

Chairman: Fred R. Low, representing the American Society of Mechanical Engineers.

Secretary: W. P. Cutter, representing the American Institute of Mining Engineers, and Librarian of the United Engineering Societies.

Executive Committee: The above officers, with Edgar Marburg of the American Society for Testing Material, H. W. Peck, representing the American Gas Institute, and Samuel Sheldon, Chairman of the Library Board, United Engineering Society.

At this meeting, Mr. W. P. Cutter read, by request, a paper on "The Classification of Applied Science," in which, after describing the existing classifications of one of which he is the author, stated that in his opinion, none of these, although having excellent features, was complete or gave enough satisfaction to be worthy of general adoption. He outlined a plan whereby a central office could collate all the existing classifications, and with the help of specialists in the various national societies interested, might compile a general system which, although perhaps not absolutely perfect, might meet with general acceptance and adoption. It was the generally expressed opinion that such a classification, if properly prepared, might well serve as a basis for the filing of clippings, for cards in a card index and for printed indexes, and that the publishers of technical periodicals might be induced to print against each important article the symbol of the appropriate class in this system, so that by clipping these articles, a file might easily be made which would combine these clippings in one system, together with trade catalogues, maps, drawings, blue prints, photographs, pamphlets, and letters classified by the same system.

Although the Joint Committee has been unable during the summer to make a fair start upon this work, it is contemplated that active work will be undertaken early in the fall and prosecuted with the utmost diligence. In addition to the intrinsic value of the work which will be done, this movement has the added feature of bringing together in co-operation more national technical societies than have ever been brought together for any one purpose at any time. The following is a list of the societies which have been invited to participate, most of whom have accepted our invitation.

It is recommended that a committee on this work be continued during the following year.

Aeronautical Society.
American Association for the Advancement of Science.
American Ceramic Society.
American Chemical Society.
American Electrochemical Society.
American Foundrymen's Association.
American Gas Institute.
American Institute of Architects.
American Institute of Electrical Engineers.
American Institute of Mining Engineers.
American Physical Society.
American Railway Engineering Association.
American Society for Testing Materials.
American Society of Agricultural Engineers.
American Society of Civil Engineers.
American Electric Railway Association.

American Institute of Metals.
American Society of Heating and Ventilating Engineers.
American Society of Mechanical Engineers.
American Society of Naval Engineers.
American Society of Refrigerating Engineers.
American Wood Preservers' Association.
American Water Works Association.
American Institute of Chemical Engineers.
American Institute of Consulting Engineers.
American Mathematical Society.
American Museum of Safety.
Association of Railway Electrical Engineers.
Association of Engineering Societies.
Association of Iron and Steel Electrical Engineers.
Bureau of Standards.
Franklin Institute.
Geological Society of America.
Illuminating Engineering Society.
Institute of Radio Engineers.
National Association of Cotton Manufacturers.
National Association of Wool Manufacturers.
National Electric Light Association.
National Fire Protection Association.
Society of Automobile Engineers.
Society of Chemical Industry.
Society of Naval Architects and Marine Engineers.
Society for the Promotion of Engineering Education.
Society to Promote the Science of Management.

H. W. PECK, *Chairman,*
D. S. KNAUSS,
H. W. TERRY, JR.
H. VON VITTINGHOFF.

MR. WALTON FORSTALL (Philadelphia): (Written discussion communicated.) If there is a final agreement in this country on classification of engineering literature, as the report of the Committee gives reason to hope, this would be a splendid memorial to the author of the paper which awakened the recent interest of the Institute in this subject. It is fit in this place to mourn the untimely death of Mr. Knauss, who did not live to see the progress of the work he started. It is to be hoped that the task will be carried through with the least possible delay, and to that end it would seem that the representation from each society should consist of one individual as far as attendance at conferences is concerned, but by a committee embracing various branches of the industry when it becomes necessary to prepare any detail classification of gas engineering literature.

Chairman Forstall: The report of the Committee on Gas Housepiping would have been a very important paper for the Congress to hear. We hope its work will result in the adoption of standard specifications for housepiping.

REPORT OF THE COMMITTEE ON GAS HOUSE-PIPING.

In presenting this report, the Committee desires to call the attention of the Technical Committee to the fact that it has not been able to complete its work, and that this is merely a progress report.

There are several portions of the report which need development, namely: the explanation of certain terms, a further elaboration of the tables, the proper indexing, etc., and it is, therefore, recommended that the Committee on Gas Housepiping be continued for another year to finish this report or to add to it in any way it may see fit.

For the compilation of this report, a series of questions was mailed to gas companies in all cities of 50,000 inhabitants and over. Specific answers to the questions were requested and copies of material on housepiping forwarded in practically every case. The Committee at this point wishes to express its appreciation for the aid it has obtained from the various gas companies interested and also to Mr. J. M. Spitzglass for his valuable assistance in preparing the table.

Each of the sets of rules were carefully gone over and those rules common to all cities placed in the finished set of rules, while those special to any one city were, if careful consideration warranted, placed likewise in the general rules.

The rules are divided for convenience into general specifications, building services, riser locations, outlets, fastening pipe, running of pipe in connection with walls, floors, etc., and the testing and inspection of piping.

A section is also devoted to tables, the explanation of these tables being given under that portion.

GENERAL SPECIFICATIONS.

Smallest Size of Piping Allowed.—No piping smaller than ⅜ inch should be used.

Pipe and Fittings.—All pipe used should be of the best quality full weight wrought iron or steel and free from defects. All fittings (except stop cocks or valves) should be of full weight malleable iron. Galvanized fittings are preferable.

Defective Material.—Defective pipe or fittings, or pipe or fittings repaired with cement, lead, or by any other method, including calking, should not be used.

Material Not Permitted.—Unions must not be used on piping which is to be concealed.

Obstructions in Pipe.—All piping should be free from burrs or other obstructions.

Jointing Pipe Material.—Jointing material should be sparingly applied to the male end of the pipe, never in the fitting. Gas fitters cement should not be used.

Painting or Coating Pipe.—Pipe should not be painted or coated until after the first inspection.

Grading of Pipe.—Piping should be free from traps, and should grade to risers or toward a drip especially provided for removing condensation.

Breaking Sizes.—In every case when an extension is to be made, pipe should be broken at a point where the full size can be maintained. No extension should be made from a pipe of a smaller size.

Branching of Pipe.—All branches should be taken from sides or top of running lines, and not from the bottom.

Work Not Allowed.—Gas fitters should not be permitted to do any underground piping between the main and meter.

Gas Engine.—The gas supply for a gas engine should be separate. An independent service should be required, and a governing holder or other similar device acceptable to the company should be used. Before any work of installing a gas engine or piping for one is done, consultation with the gas company is advised.

BUILDING SERVICES.

Location of Building Service.—When risers are located in the rear of a basement, or in a room provided for that purpose, or on the various floors, the building service should be brought to within 3 feet of the proposed location of the street service.

Building Service Header.—When it is necessary to set more than two meters together, a building service header should be supplied with an opening for each meter, and these openings should not be less than 15 inches apart.

Grading of Building Service.—A building service should be graded to the street, and in any horizontal run the tee left turned up so that any condensation forming in the pipe will run to the street and not to the meter.

Wrapping Building Service.—An exposed building service should be covered with mineral wool or steam pipe covering and boxed in.

Opening in Building Service.—The opening in a building service should be on the left hand side of the riser which it is to supply, and not less than 15 inches from it.

RISER LOCATIONS, ETC.

Location for Meter.—The gas company reserves the right to determine in all cases the location of the meter.

Prohibited Locations for Risers.—A riser must not end in any place where the gas company's meter will be exposed to frost, dampness, extremes of temperatures or be liable to injury from any cause.

Locations specifically prohibited:

Under a bulkhead or show window.

Horse stall or any place in a barn where it would be liable to injury.
Sleeping apartment.
Stairway closet.
Bedroom closet.
Under a sink or washstand.
Over a toilet stool.
In the way of a toilet flush tank.
Over a gas or electric light.
In a closet that is not properly and permanently ventilated.
In a moving picture machine booth.
Under stoops.
Directly in front of a boiler or furnace.

Electric Cut-Off Box.—A riser should never be brought to a point nearer than 5 feet to an electric cut-off box.

Piping for Laundry Room.—In a building where appliances such as laundry stoves, driers, etc., are installed for the joint use of tenants, a pipe from each tenant's meter should be run to the laundry room and a header provided on the wall adjacent to the appliance. Each riser should be equipped with a lock cock.

A metal tag with the proper designation marked thereon should be fastened to each cock.

One outlet for a light in the laundry may be taken from the end of the laundry header.

Alignment of Risers.—Where meters are to be located at one point, the risers should not be scattered, but should drop in alignment to the basement at a convenient point, with a clear space of not less than 3 inches between any two of them, and they should be extended horizontally to within 3 feet of the proposed location of the meters.

Distance Below Ceiling.—A riser must extend not less than 1½ inch below a finished ceiling, or 2 inches below an unfinished one.

Riser Termination.—All risers should preferably end in public basements provided the latter are dry and warm, and are not less than 7 feet in height.

If no public basement or meter room is provided, the riser for each floor should end either in the toilet, pantry or kitchen of that floor.

Riser Termination, Separate Apartments.—When the riser for separate apartments ends in each apartment, it must be extended to within 18 inches of the outlet on the building service and to the right of it, facing the riser.

Riser Termination, Single One in Building.—Where there is only one riser in a building, it should be brought to a point within 3 feet of the head of the service.

Riser in Basement, Cold Climates.—When climatic conditions may be severe, a riser in an unheated basement should be located at least 4 feet from an outside wall.

Riser Obstruction.—Risers should not terminate in a place where beams, girders, or heater pipes, which may be installed subsequently, will interfere with making connections to meter.

Tee on End of Riser.—A tee with a full sized opening looking down, should be placed on the end of every vertical riser. In the opening a short nipple and cap should be used.

Riser in Vestibule Partition.—A riser should not be run closer than 3 feet to a vestibule partition.

Piping on Outside Wall, Cold Climates.—A riser should not be run on outside wall if there is an inside partition wall available. If there is no partition wall available, the pipe should be run near a chimney breast of the exposed wall.

OUTLETS FOR LIGHT AND FUEL.

Capping Outlets.—All outlets must be securely closed with iron caps or plugs until fixtures or appliances are installed.

Outlets for Side Brackets.—Outlets for side brackets may be either square bends or long drop ells. The use of nipples is prohibited. Care should be taken in bending the pipe that it does not kink. The outlets should project not more than 7/8 inch or less than 5/8 inch, and should be firmly secured at right angles to the wall.

Drops from Branch Lines.—Drops from branch lines should have a set of 4 inches, and they must be dropped square. The use of nipples is prohibited. Care should be taken in bending the pipe that it does not kink.

Drops.—Drop outlets should be produced from 1½ to 2 inches below an unfinished ceiling or ¾ inch below a finished one.

Outlets for Illumination.—Outlets for illumination should not be placed under tanks, back of swinging doors, or within 4 feet of the place where the meter is to set, or in any other location where good practice forbids.

Outlet for Fuel.—If the pipe has been run under the floor the outlet for fuel should be left 3 inches above the floor and 2 inches clear of the baseboard. If, in the kitchen, the pipe has been run overhead and down, the outlet should be left 3 feet from the floor and 2 inches clear of the finished wall. If, in other rooms, the pipe has been run overhead and down, the outlet should be left 3 inches above the floor and 2 inches clear of the baseboard.

Outlet for Mantle or Fireplace.—An outlet for a mantle or fireplace should be produced 1½ inches above the finished bottom of the fireplace and 6 inches from the back and left hand side of the fireplace.

FASTENING PIPE.

Fastening Pipe, Building of Ordinary Construction.—All piping must be securely and rigidly fastened by hooks, straps or pipe hangers screwed to the woodwork. When the piping does not run sufficiently close to the woodwork to admit of its being securely fastened, wooden strips spaced at intervals, as given below, should be provided. These strips should be securely fastened to the woodwork.

⅜ or ½-inch pipe	6 feet
¾ or 1-inch pipe	8 feet
1¼, 1½ or 2-inch pipe	10 feet

No piping should be laid to support any weight (except fixtures) or be subjected to any extra weight whatsoever.

Fastening Pipe, Building of Concrete or Tile Construction.—When concrete or tile are used in the construction of floors or partitions, the piping, whether concealed or exposed, should be supported and fastened by the use of straps, hooks, or pipe hangers held to the wall or ceiling by the use of expansion bolts.

Piping on Masonry Walls.—All piping run on masonry walls should be secured thereto by fastening it to wooden plugs driven into the wall, or to metal expansion plugs imbedded in the wall.

PIPING IN CONNECTION WITH FLOORS, ETC.

Imbedding Pipe in Concrete or Cement.—When it is necessary that pipe be imbedded in concrete or cement, it should be covered with some suitable protecting material, or it may be laid, uncovered, in a conduit pipe.

Encasing Pipe Through Masonry Walls.—Where piping passes through masonry or tile walls, it should be encased and the pipe left resting on the bottom of the casing pipe with at least ½ inch clearance on top.

Offset in Foundation Wall.—Where the thickness of a foundation wall is increased and when the end of the riser would ordinarily terminate on the top of the thicker portion of the wall, thus making the bottom of the riser inaccessible, the piping should be offset by using a 45° ell so placed as to bring the end of the riser clear of the foundation wall.

Running Lines, Ordinary Buildings.—In buildings of ordinary construction (with flooring of single thickness laid across the joists and with ceilings lathed and plastered below the joists) the horizontal piping should be located just under the floor boards, passing over the joists, which should be notched to a depth of not more than 2 inches, this notching to be within 3 feet of the point of support of the joist.

Piping Under Tile, Etc.—Piping should not be laid under tiled, parquet or mosaic floors when it can be avoided. In some cases the piping may be left exposed below the ceiling;

when beams or girders are to be exposed, piping may be concealed by a moulding.

Vertical Pipes.—Vertical pipes, if they must be concealed, should, as far as possible, be located in hollow partitions, in preference to being placed in the studding or lathing back of the plaster on masonry walls.

TESTING AND INSPECTION.

Inspection of Piping.—All piping installed should be inspected before it is concealed and tested;

First.—Before the piping is concealed.

Second.—After all work in the building which might disturb the piping has been completed, and before the fixtures are installed.

Third.—After fixtures have been installed.

Gas fitters must have work completed and system tight before applying for test. It is advisable to give at least 24 hours notice before requesting test.

Testing.—Before fixtures are installed, the piping should stand a pressure of three pounds per square inch indicated by a column of mercury 6 inches high. The column should show no drop for a minimum of time of 10 minutes. Before fixtures are installed, air pressure must be up to all caps or plugs.

After fixtures are installed, the system should stand at least a pressure of approximately ¼ pound per square inch indicated by a column of water 6 inches high. The column should show no drop for 10 minutes.

New Piping Connected to Old Piping.—A system of new piping that is to be joined to a system of old piping, thus constituting an extension to the old piping, requires the regular first inspection, before being joined to the old piping. After this first inspection, and the new piping is connected to the old piping, the whole enlarged system of piping should be required to stand a pressure of 6 inches of water column, showing no drop in 10 minutes. This applies whether or not any fixtures are on the old or new system of piping.

Use of Acid.—Acid or any other liquid should not be used to test or tighten piping.

RULES AND TABLES FOR PIPING.

Single Pipe System.—The following tables have been worked out on the assumption that a single pipe system only will be required in any building. Should it be more economical, however, to install a double pipe system, this may be readily done, the combined system being computed on the same basis as is the single pipe system.

Equivalent Openings.—The basis for the computation of these tables is taken as a ⅜ inch opening, and all appliances refer to this size opening. For example, it is assumed that an ordinary kitchen range will require approximately 60 cubic feet per hour or six times the amount of gas which a ⅜ inch opening will pass. The table used is as follows:

Range for flat or residence	6 openings
Grate or log	3 openings
Laundry appliance	3 openings
Water heater	5 openings
Arc lamp	2 openings

SIZE OF OUTLETS

	Size in inches								
Outlets	⅜	½	¾	1	1¼	1½	2	3	4
Value in ⅜″ openings	1	2	4.5	9	19.7	30.6	62	184	384

Tables of Sizes.—In working out the appended tables, a plan different from that employed in figuring the usual tables of sizes was adopted, based upon the following assumptions: (the Spitzglass slide rule was used throughout since this rule checked directly with actual piping systems installed).

It was assumed that the piping of the building be divided into sections, the number of sections depending upon the allowable drop in pressure from the meter to the end of the housepiping. For example, if it is assumed that a drop of 6/10 inch be permissible in a certain building, the total piping system might be divided into six sections of the following sizes: ⅜, ½, ¾, 1, 1¼, and 1½ inch, this giving 1/10 inch drop in pressure for each section.

1/10″ DROP PER SIZE. Water gas. Sp. gr. 65.

No. ⅜″ openings	Size of pipe in inches								
	⅜	½	¾	1	1¼	1½	2	3	4
1	60	245	1,200						
2	15	61	300	1,220					
3	6	27	132	540					
4		15	76	300					
5		9	48	194	930				
6			33	134	650				
7			24	99	475				
8			19	75	365	870			
9			15	60	287	690			
10			12	49	233	555			
11			10	40	192	465			
12			8	34	162	390			
13				29	138	332			
14				25	118	285	1,170		
15				22	104	250	1,020		
16				19	92	220	900		
17				17	81	194	790		
18				15	72	173	710		
19				13	65	155	640		
20				12	59	140	570		
21				11	53	126	520		
22				10	48	116	475		
23				9	44	106	432		
24				8	40	97	400		
25					37	89	365	5,250	
26					35	83	338	3,000	
27					32	77	314	2,800	
28					30	72	292	2,600	
29					28	67	272	2,440	
30					26	62	254	2,250	
31					24	58	238	2,120	
32					23	55	223	2,000	
33					21	51	210	1,870	
34					20	48	198	1,770	
35					19	45	186	1,670	
36					18	43	176	1,580	
37					17	41	166	1,500	
38					16	39	158	1.420	
39					15	37	150	1,340	
40					14	35	143	1,280	5,600
45					11	27	113	1,000	4,400
50					9	22	91	840	3,550
60						15	63	570	2,450
75						10	40	360	1,580
100							23	200	890
125							15	132	570
150							10	81	400
175								67	290
200								51	220
300								22	99
400								13	55
500								8	35
750									19
1,000									9

1/10" Drop Per Size. Coal gas. Sp. gr. 50.

No. ⅜" openings	Size of pipe in inches ⅜	½	¾	1	1¼	1½	2	3	4
1	78	315	1,560						
2	20	79	390	1,580					
3	8	35	172	700					
4		20	98	390					
5		13	62	250	1,220				
6		9	43	174	840				
7			32	128	640				
8			24	99	475	1,140			
9			19	77	375	900			
10			15	63	300	730			
11			13	52	250	600			
12			11	44	210	520			
13			9	37	178	430			
14				32	155	370	1,520		
15				28	135	325	1,325		
16				25	118	285	1,160		
17				22	104	250	1,030		
18				19	95	225	920		
19				17	84	200	830		
20				16	76	182	750		
21				14	69	165	675	6,000	
22				13	63	150	610	5,500	
23				12	58	138	560	5,000	
24				11	53	126	520	4,600	
25				10	49	116	475	4,250	
26					45	108	440	3,950	
27					42	100	410	3,650	
28					39	93	380	3,400	
29					36	87	355	3,150	
30					34	81	330	2,950	
31					32	76	310	2,760	
32					30	71	290	2,600	
33					28	67	270	2,450	
34					26	63	255	2,300	
35					25	60	242	2,170	9,400
36					24	57	230	2,050	8,950
37					22	54	217	1,940	8,500
38					21	51	205	1,840	8,050
39					20	48	195	1,740	7,650
40					19	45	185	1,660	7,250
45					15	46	146	1,310	5,700
50					12	29	118	1,060	4,625
60					8	20	83	740	3,200
75						13	53	470	2,050
100						7	30	265	1,160
125							19	175	740
150							13	118	515
175							10	87	380
200								67	290
300								30	128
400								17	72
500								11	46
750									20
1,000									12

The table will then give the total length of any sized pipe for 1/10 inch drop in pressure which may be run for any consumption, and if the total length is run, the 1/10 inch drop in pressure will be entirely used up. It will be seen, therefore, that the total 6/10 inch drop in pressure can be distributed amongst the six sizes of pipe to the best advantage, for if the drop is not used up in one section, the remaining drop for that section may be applied to the next section.

The sizes and lengths may be then worked out in a manner similar to any other table of this type.

C. E. REINICKER, *Chairman,*
H. B. ANDERSEN,
J. J. BURNS,
F. C. MILLARD,
B. F. PELTON,
A. E. TURNER,
G. I. VINCENT.

(As the ensuing written discussion, which was communicated after the meeting, refers specifically to various paragraphs of the report, it has been thought wise to group this discussion by topic rather than by author. The contributors of this discussion are:

(1) H. B. Andersen, Philadelphia, Pa.
(2) J. J. Burns, St. Louis, Mo.
(3) O. B. Evans, Philadelphia, Pa.
(4) National Fire Protection Association, Chicago Meeting, 1915.
(5) B. F. Pelton, St. Paul, Minn.)

Smallest Size of Piping Allowed:

(1) Add: "No pipe extending outside the main wall of a building should be smaller than ¾ inch. No pipe laid underground should be smaller than 1¼ inch."

Pipe and Fittings:

(4) Change to read: "All pipe used shall be standard, full weight, of the best quality wrought iron or steel, and free from defects. All fittings (except stop cocks or valves), shall be of

best quality malleable iron. Fittings galvanized on exterior only are preferable."

(5) Include beaded fittings. Are galvanized fittings preferable to black fittings without flaws?

Defective Material:

(4) and (5) Consider the welding of pipe.

Jointing Pipe Material:

(4) Change to read: "In making up the joints of gas piping, white lead, red lead, or any other approved jointing compound shall be used, and this shall be applied sparingly to the male thread of the pipe or fitting and not to the female thread of the fitting. The use of gas fitter's cement is prohibited as a gas piping compound."

Work Not Allowed:

(5) How can we prevent plumbers installing pipes back of the meters? The pipe back of the meter belongs to the property owner of the property line, and I believe the courts will permit him hiring any reliable plumber to install this pipe if he so desires, and we will be obliged to supply gas through his pipe.

Gas Engines:

(1) Neither advisable nor necessary to specify a separate service.

(4) Change second sentence to read: "An independent service should be required, a suitable cut-off valve provided at the engine and an approved pressure equalizer, or other device acceptable to the company, should be used."

Wrapping Building Service:

(4) Change to read: "An exposed building service should be properly protected by an incombustible covering."

(5) I understand that this applies to service pipes exposed outside of the building, or in extremely cold places, and does not refer to pipes in basements or extending through the building itself.

Opening in Building Service:

(4) The distance 15 inches, as specified in this paragraph, is given as 18 inches by Mr. A. E. Turner in his paper "Proper Specifications for and Inspection of Interior Gas Piping" (p. 1319 Vol. II, American Gas Institute, 1914 PROCEEDINGS). This latter dimension is specified for a similar condition in a succeeding paragraph of this report entitled "Riser Termination, Separate Apartments."

Location for Meter:

Prohibited Locations for Risers:

Locations Specifically Prohibited:

(2) The second paragraph, as written without any qualifications, is in contradiction to the following line under *Locations Specifically Prohibited*: "Over a toilet stool."

(4) Opinion was expressed to the effect that prohibited locations should not be specified in detail, but the specifications for meters would follow somewhat the general prohibition use in Mr. W. R. Addicks' report of this Association on "Gas Meter Specifications," which was as follows:

"The meter should be placed where it will not be subjected to extreme heat or cold, and where, when possible, it will not be necessary to use artificial light in indexing or doing any other work about the meter. Meters should not be placed in coal or wood bins, closets or in any small confined places, nor in spaces not at all times readily accessible nor where there is a likelihood of their being damaged through corrosion or accident. They should not be placed near coal-chutes."

Distance Below Ceiling:

(1) A maximum distance, say of 3 inches, also should be specified.

Riser Termination:

(5) Why not insist on placing meters in public halls or basements, and absolutely refuse to set meters in new buildings unless so provided for?

Riser Termination, Single One in Building:

(1) Change to read: "Where there is only one riser in a building, it should be brought to a point within 3 feet, measured in a horizontal direction, of the proposed head of the service."

Outlets for Side Brackets:

(1) Change last sentence to read: "The outlets should project not more than ⅞ inch nor less than ⅝ inch from a finished wall, and should be firmly secured at right angles to the wall."

Fastening Pipe, Building of Concrete or Tile Construction:

(4) This paragraph is referred to the Committee for further consideration.

Piping on Masonry Walls:

(4) This paragraph is referred to the Committee for further consideration.

Imbedding Pipe in Concrete or Cement:

(3) It has been our practice in laying pipe under ground in bad soil, to cover it completely with cement. Is there any necessity for protecting housepiping from cement, and what would such a protecting covering consist of?

(4) This paragraph is referred to the Committee for further consideration.

(5) What is meant by "some suitable protective material" and why is it necessary?

Encasing Pipe Through Masonry Walls:

(4) Add: "The opening, when through a fire wall, to be filled in with mineral wool or other non-combustible compressible material."

Offset in Foundation Wall:

(4) This paragraph is referred to the Committee for further consideration.

Vertical Pipes:

(4) This paragraph is referred to the Committee for further consideration.

Inspection of Piping:

(1) Under this heading, insert the following: "When any system of piping, installed to supply fuel appliances alone, is to be entirely and permanently exposed, the inspection requirements will be met by a visual inspection of the quality of the work, and a verification of the size requirements."

This suggestion is made with the thought that an inspection of exposed piping need not be as rigid as that of concealed piping.

(4) Change first sentence to read as follows: "All piping installed should be inspected and tested by the inspection department having jurisdiction."

Testing:

(3) In some places it is customary to uncap a distant outlet of a housepiping system to make sure that there is not intentional or unintentional stoppage in the housepiping close to the point of test. Would it be well to cover this point?

(4) Change to read: "Before the fixtures are installed, the piping should stand a pressure of not less than 5 pounds per square inch indicated by a column of mercury not less than 10 inches high. The column should show no drop for a minimum time of ten minutes. Before the fixtures are installed, the air pressure must be up to all caps or plugs. After the fixtures are installed, the system should stand a pressure of at least twice the working pressure, but never less than a column of water 6 inches high. The column should show no drop for 10 minutes."

Add at this point the following:

(4) "*Turning on Gas*:

Gas will not be turned on until all inspections have been made and the proper certificate has been filed with the gas company."

New Piping Connected to Old Piping:

(4) Change second sentence to read: "After this first inspection, and the new piping is connected to the old, the whole enlarged system should be required to stand a pressure of at

least twice the working pressure, but never less than a column of water 6 inches high, showing no drop in 10 minutes."

Use of Acid:

(3) While the use of acid for testing housepiping is properly objected to, is there any reason why ether or some such volatile liquid should not be used for locating leaks?

(4) Change to read: "Water, acid or any corrosive liquid should not be used to test or tighten piping."

Equivalent Openings:

Size of Outlets:

(1) In view of the fact that the term "outlets" has been used throughout the rules, it would seem proper to replace the word "openings" by "outlets."

Table of Sizes:

(1) I realize that it is improbable that we can easily agree on a table of sizes. For the sake of discussion, and for my own help in understanding the proposed table correctly, I would like to make the following comments:

When making a table which might be adopted for general use, I believe that this table should follow very closely any existing tables, if in practice the existing tables have required pipe of sufficient size. I think that the cost of installing pipe slightly larger than theoretically necessary, is so very slight as to cut no figure, in comparison with the advantages gained from the larger pipe. I believe that it was stated that a large majority of the gas companies which sent replies to the set questions, stated that they were using a simple form of table of the form below given, and with these limiting lengths. This form of table is first found, I believe, on page 33 of King's Treatise, Vol. III.

Inside diameter pipe, inch	Greatest allowable length, feet	Greatest number of outlets allowed
3/8	20	1
1/2	30	2
3/4	50	6
1	70	12
1 1/4	150	22

As this table is actually in use in many situations, and is proving satisfactory in many of which we know specifically, I believe that it would be wise to allow the maximum lengths to remain as they are now being used. Such a radical difference as would result from a change from the present standards (even such as they are), to the standard proposed in the table in the report, would have no marked advantage and very marked disadvantages; namely, that due to the resultant confusion between gas company and gas fitters, and that due to decreased mechanical strength and capacity.

I have in mind a main feed line for one of the floors of a comparatively small hospital building which is being erected near my office. According to the proposed table, the drop in the line on this one floor is 0.41 inch, which is too great to allow in practice in many locations. If I were to figure out a system of piping similar to that in a large building, one of our public schools, for instance, the drop would be considerably over 1.0 inch. Under these conditions, which are not extraordinary, it would be very unwise to use the table proposed.

My specific questions about the table proposed follow:

I do not know what is referred to by the statement that "the Spitzglass slide rule checked directly with actual piping systems installed." If any experiments have been conducted, I think it would be appropriate to describe them in a foot-note. The statement is made that it was assumed that the number of sections into which the piping of a building should be divided would "depend" on the allowable drop in pressure from meter to end of piping system. I cannot see what relation these two features are assumed to bear.

Again, it is stated that if a 0.6 inch total drop is assumed, then the total piping system "might" be divided into six sections, or six sizes, of piping, and a 0.1 inch drop assigned to each section. Following up this method, would the assumptions lead to the proposition that if only 0.3 inch drop were allowable, then only three sections and three sizes be proposed? If this is not following up the assumptions as is intended, I do not clearly understand the method, but if I am correct in my understanding, I believe that the method is not practical. I say this because, given the same system of piping under the 0.3 inch as under the 0.6 inch drop, and working it out as per the idea, even with a table made on 0.1 inch per size basis, we would soon come to a point where the maximum lengths for the three sizes might be used up, and any longer run of pipe would cause a drop in pressure which would make the total more than the 0.3 inch allowed.

In the description of the table proposed, no statement is made that there is a maximum length of each size pipe that cannot be exceeded. For example, take the column headed ¾ inch pipe. We can run 132 feet to supply three outlets, 76 feet for four outlets, and so on, up to twelve outlets. However, if pipe were actually run this way, the total drop would be 1.0 inch. In all existing tables, a maximum length is given, not to be exceeded when running lines of pipe to supply outlets at intervals along the line. This feature in existing tables is desirable, and I believe it an added reason why the very long lengths in the proposed table should be eliminated, and the feature here mentioned, incorporated.

I have made a few statements as to my opinion as to the desirability of the shorter lengths as used in existing tables. I believe that a proposed table should be formulated after making the following assumptions:

1. Consumption per outlet 10 cubic feet.
2. Rate of drop not to exceed 0.1 inch in 30 feet.
3. Maximum length not to exceed that shown in existing tables mentioned in Mr. A. E. Turner's paper, read at last year's Institute meeting.
4. Drop per length between two adjacent outlets or branches not to exceed 0.04 inch.

Whether or not the figures assumed could ever be such that the table would show piping adaptable to all conditions of pressure and service, is questionable.

MR. WALTON FORSTALL (Philadelphia): (Written discussion communicated.) There is a crying need for standard specifications, approved by the Institute, governing the installation and testing of housepiping. In too many cities of this country, it is still true that the gas company cannot, and the city does not exert any control over this piping, with the natural result that the user of gas suffers from leaks and poor supply. Each company should at once read the report carefully and decide whether or not it is willing to agree to the contents, with especial reference to the tables and their applicability to practical conditions. Comments could with great advantage be published in the *News* during the year in the hope that by the fall of 1916, agreement could be reached on the subject.

CHAIRMAN FORSTALL: I will call on the Chairman, Mr. Bond, for the report of the Committee on Gas Lighting.

MR. C. O. BOND (Philadelphia): I would like to have this report accepted by the mere reading of the title. It includes a 70 page glossary prepared by Mr. R. B. Harper, of all terms used in, or in some way related to, gas lighting. He has culled all the transactions and technical journals in the effort to include all, and has then offered a tentative meaning for each, so that there will be no misunderstanding between us in their use.

The remainder of the report is in the nature of a progress report. We are covering a range of 400 to 700 B. t. u. to find at what B. t. u. value gas is most efficient for present gas lamps.

Another portion deals with a tentative method of rating lamps, by which certain selected lamps will be tested at four laboratories in different cities with the hope that the basis of rating we have now in mind will be found satisfactory for adoption.

REPORT OF THE COMMITTEE ON GAS LIGHTING.

The appointment of the Committee on Gas Lighting was the outgrowth of the Illumination Section meeting at the annual meeting of the American Gas Institute, October 22, 1914.

The duties of this Committee are "to investigate and report on lamps, mantles, fixtures and piping and other engineering aspects of gas lighting."

In order to definitely outline the work of the Committee a list of 13 possible activities, suggested by discussion at the annual meeting, was drawn up, and full discussion requested as to their order of importance.

A meeting of the Committee was then held in the office of the American Gas Institute, 29 W. 39th Street, New York City, on March 24, 1915, at which the replies from the several members of the Committee were analyzed, and the decision was reached to undertake work on the four voted as of first importance; and to begin others if the way opened so to do. These first four were:

1. Prescribe standard conditions for testing gas lamps in order to determine their rating.

2. Reach an agreement, if possible, as to the proper place or places for such tests and begin the collection of actual data on the efficiency performance, distribution curves, etc., of lamps to be rated in accordance with paragraph 1.

3. A study of the methods of ignition, including distance ignition, looking to the approval of those which are safe, certain and convenient.

4. Determine the characteristics of the ideal gas suited to give high efficiency and good service with present lamps on the market.

This should include a specification of the limits within which such gas should be manufactured, as measured in terms of specific gravity, candle-power, calorific value and pressure at the consumers' appliances, though of course in practical operation, it is the hope that a single test such as a calorific test would be a sufficient guide in manufacture.

As a preliminary investigation relating to the first of these subjects, it was decided that a series of careful tests should be made at four representative laboratories, in order to determine to how close an agreement the laboratories could come in rating lamps under the present methods of testing.

Lamps.—In making this test it was decided to use three representative types of lamps (1) three burner inverted arc lamp, equipped with clear globe, (2) single burner inverted lamp, equipped with clear air-hole cylinder and (3) single burner upright lamp, equipped with clear air-hole chimney.

Mantles.—The mantles used on this test are to be specially selected with regard to uniformity in size and shape.

Elimination of Color Differences in Photometry.—The elimination of color differences between the standard light source and the lamp under test seemed highly important.

Dr. H. E. Ives and Mr. E. F. Kingsbury, of The United Gas Improvement Company's Physical Laboratory have proposed an application of Crova's method (*Comptes Rendus,* 93, 512) for this purpose.

The method consists briefly in choosing such a monochromatic color of the spectrum as will cause the intensity of the lights under comparison to be represented by their relative intensity at this wave-length.

In practice a monochromatic green solution, in a suitable container, is interposed between the eye and the comparison field. The transmission of this solution has been carefully calibrated so that it may be used with the various types of standard light sources.

For a detailed description of the method see "The Application of Crova's Method of Colored Light Photometry to Modern Illuminants," by Dr. H. E. Ives and Mr. E. F. Kingsbury; Paper presented at the Illuminating Engineering Society Convention, 1915.

Gas Pressure.—The lamps are to be tested at each laboratory on four gas pressures, the minimum, mean and maximum ordinarily encountered in practice at the particular locality and at one common pressure, chosen at 3.0 inches water differential.

Consumption.—At each pressure, readings are to be made at five different consumptions, varying each side of the rated, and curves plotted for each lamp (candle-power and efficiency as ordinates and corrected consumptions as abscissas).

At each consumption, the air shutter is to be regulated so as to give maximum candle-power.

Efficiency Rating.—The efficiency ratings are to be recorded in terms of lumens per total B. t. u. hour input of energy. (Correction for effect of humidity on mantles to be applied.)

$$\text{Efficiency} = \frac{\text{Lumens}}{\text{Total B. t. u per cu. ft.} \times \text{corr. cons. per hour}}.$$

The following data is to be recorded:

(1) Kind of gas. If possible a statement of the process of gas manufacture should be given and if a mixture of different process gases is used, then the proportion of each should be stated.
(2) Calorific value.
(3) Specific gravity.
(4) Chemical analysis.
(5) Atmospheric pressure.
(6) Humidity of air.
(7) Gas pressure at lamp inlet.
(8) Gas pressure in meter.
(9) Correction factor for gas volume.
(10) Open flame candle-power of gas (use 8' E. H. Lava tip).
(11) Kind of standard lamp used. Corrected candle-power.
(12) Gas meter corrections.
(13) If possible the percentage of CO_2 in the air.

The following laboratories have agreed to undertake the tests:

Laboratory of the Peoples Gas Light & Coke Co., Chicago, Laboratory of the Consolidated Gas Company, of New York. Bureau of Standards (co-operating with committee), Washington, D. C., Physical Laboratory of The United Gas Improvement Co., Philadelphia.

Committee members and participating laboratories have been acquainted by circular letter with the proposed details of the method of test which seemed most logical.

The lamps and mantles have been secured from two manufacturers and the tests are now under way.

The results of this set of tests on identical lamps by different observers using different photometers and different gases, will serve to disclose whether the proposed method found to have claims for feasibility in a given locality, can in practice recommend itself for general adoption.

Standard Mantles.—In connection with subject 1, prescribing a standard method of testing gas lamps in order to determine their rating, the necessity for the adoption of a standard mantle in making such tests becomes very apparent.

The rating given to any particular burner applies only when mantles, similar to those employed in making photometric tests, are used.

In practice during the life of a burner many different brands of mantles are often used on it, and as a result, the efficiency may vary widely. Furthermore, the use of mantles, made to different specifications, on various burners gives no idea of the relative merits of burner construction.

Tests which have been made show that for a particular shape and size of mantle, variations in candle-power, on a constant gas consumption of as high as 30 per cent., can be easily obtained by making a so-called "flash mantle."

Assuming that practically all commercial mantles are made from the same fundamental base, thorium dioxide and cerium dioxide, the general description of a "flash mantle" is one which has been made very light in weight. Other burning conditions unchanged, if the percentage of cerium dioxide remain constant, the lighter a mantle is made in weight for a unit area of effective radiating surface, the whiter the light becomes and the greater the candle-power, and with the conditions just stated, if the *color* of the light be kept constant by the addition of slight increments of cerium dioxide, an increase in efficiency will result.

The strength and general serviceableness of a mantle manufactured from a given base is a function of the weight per unit area—the lighter the weight, the less resistant it becomes to shock, etc.

The logical standard mantle would then be one which compromises between maximum strength and maximum candle-power, determined by practical and laboratory tests.

A series of tests is now going on, having for its purpose to find, under the careful test conditions above specified, how much variation exists in a batch of mantles made under expert manufacture to a common standard.

It seems highly desirable that gas lighting units should be properly standardized in order to avoid confusion in the efficiency ratings of lamps, and for other obvious reasons.

Efficiencies of Lamps on Various Gases at a Given Station.—The investigation of topic 1 at a single station, as contributing information towards a method of rating, has progressed further than the main inquiry, and has been carried on by testing standard equipped lamps on local gases of different composition.

The first investigation made consisted in testing two each of (1) two types of upright lamps, (2) a single burner inverted lamp and (3) an upright Bunsen inverted mantle lamp, at constant pressure, on water gases, varying in calorific value from 490 to 680 B. t. u. per cubic feet.

The results to date, extending over a period of four months, have been secured at one laboratory where facilities existed for obtaining gases of varying qualities. These results have been plotted graphically, but will not be published until completion of the tests and subsequent committee discussion.

In the work thus far done, the aim has been to consider the calorific value of the gas as the variable, and on this basis, to seek that gas which gives (1) highest efficiency or (2) greatest range in satisfactory burner adjustment under a constant pressure, as an indication of a gas which would cause least trouble to the consumer.

C. O. BOND, *Chairman,*
J. E. BULLARD,
R. B. HARPER,
ARTHUR HEWITT,
D. E. KEPPELMANN,
NORMAN MACBETH,
THOMAS SCOFIELD,
C. H. STONE,
BUREAU OF STANDARDS.

MR. D. L. HILL (Toronto, Ont.): (Written discussion communicated.) I shall be very much interested in learning the results of the tests which the report contemplates, and the efficiency of gases varying in calorific value from 490 to 680 B. t. u. per cubic foot. From this report, it should be possible to determine with some degree of accuracy the part which "flame temperature" plays in the efficiency of incandescent burners, and to what extent the actual consumption of gas of, say, 500 B. t. u. will be greater than the consumption of gas of, say, 650 B. t. u.

As we know, hydrogen and carbon monoxide have a very low calorific value, and "Blue" water gas, theoretically composed of equal volumes of these gases, has a calorific value of approximately 316 B. t. u. per cubic foot, but the flame temperature of carbon monoxide (3760° F.), is the highest among all the gases to be considered in connection with town gas, and that of hydrogen (3542° F.) is very close to it.

Benzene, on the other hand, with a calorific value of 3845 B. t. u. per cubic foot, has a flame temperature of 3662° F., being less than that of carbon monoxide, and only a little above that of hydrogen. Its homologue, mesitylene, has a calorific power of 6106 B. t. u., while the flame temperature of mesitylene (3606° F.) is less than that of carbon monoxide, and only a trifle above that of hydrogen.

The cause of this is that the higher the calorific value of a gas, the more air is required to burn it, and the cooling effect of the nitrogen contained in this air nearly counterbalances the extra heat set free during combustion; so that within certain limits, "the flames of all gases and mixtures of gases *burnt with the proper quantity of air* have approximately the same temperature." Hence, for incandescent lighting, a gas of low calorific value, if burnt with the proper quantity of air, will be as efficient as one of much higher calorific value.

The reference in the report to Crova's method of testing different colored lights, is new to me. The Flicker disk box was designed for the purpose of overcoming the difficulty of determining lights of differing tints, and I am somewhat curious to know why this method is set aside in favor of Crova's.

Mr. L. H. Scherck (Poughkeepsie, N. Y.): (Written discussion communicated.) I have made a careful study of this report to see if I could add, subtract, criticise or commend the Committee's work. I realize, however, that I can add very little to the report in question, and feel that my remarks must be confined mostly to a commendation of it.

The duties of the Committee being as outlined in the beginning of the report, it seems to me wise that a decision was arrived at to undertake the work on the four topics voted as of first importance. Further, these topics seem to be of prime importance to the industry, especially the third, "A Study of the Methods of Ignition, including Distance Ignition, Looking to the Approval of Those which are Safe, Certain and Convenient." If gas illumination is to progress, I believe we must satisfactorily solve the problem of distance ignition. It might likewise be of value if particular stress is laid on the effect of variation in pressure upon various kinds of incandescent burners.

The Committee is to be complimented on the report.

(President Jones resumes the chair.)

The President: The preparation of these reports occupied the mind and attention of some of our very best men for a period covering nearly a year, and it seems a pity that we should not have a full reading and proper discussion of them. But, under the circumstances, as the American Gas Institute meets with the International Gas Congress in a city where one of the most attractive expositions the world has ever seen is being held, and the attraction of that exposition is drawing you out of your seats,—we are sacrificing the interests of the American Gas Institute in the interest of the pleasure of its members. And as your President, I want to suggest that a full discussion of these reports shall be furnished by the members in writing, and shall request our Secretary to call attention to this request in the columns of the Gas Institute *News,* so that when our PROCEEDINGS go to press the various reports shall not be neglected in any way, and our 1915 PROCEEDINGS shall be full and adequate.

The next report is that on Gas Works Auxiliaries by Mr. J. M. Spitzglass, of Chicago; and I know Mr. Spitzglass has spent the greater part of the year in preparing it, so that we will now give him ten minutes to present an abstract.

(Mr. Spitzglass then read an abstract of his report.)

REPORT OF THE COMMITTEE ON GAS WORKS AUXILIARIES.

Gas Work Auxiliaries can be divided into two general classes. The first class includes the wide variety of instruments which the gas engineer may use in keeping himself informed of the conditions of operation in the plant. Such instruments as thermometers, pyrometers, pressure and draft gauges, fuel calorimeters, gas and oil testing apparatus, gas steam and water meters, electrical appliances and various other devices belong to this class. The second class of auxiliaries includes exhausters, blowers, compressors, and various engines and machinery not directly engaged in the making of gas.

The present report of the committee is limited to auxiliary devices of the first class, and covers the measurement of volumes, pressures and temperatures in the gas works. The report is divided into three parts.

Part I. The development of an averaging Pitot tube device for measuring the flow of gases in pipes.

Part II. Various types of pressure gauges, manometers, and U-tubes, their use and proper application in the gas works.

Part III. Various types of pyrometers, basic principles of their operation, and proper application in the gas works.

PART I.—THE PITOT TUBE.

The Pitot tube has been employed for many years as a scientific device for measuring the velocity of gases and liquids in closed channels and pipes. The instrument, as being used mainly in testing work and laboratories, comprises two small tubes inserted into the pipe where the flow is to be measured. One of them called the *dynamic* tube has the open end bent 90 degrees, and is inserted into the pipe with the opening facing the flow. The other tube, called the *static,* has the open end placed at right angles to the flow, presumably in such a condition that neither the pressure nor the suction created by the flow should have an effect upon the pressure transmitted through this tube. When the two tubes are connected to the ends of U-tube water gauge, the displacement of the water column indicates the pressure difference equivalent to the velocity of the flow facing the opening of the dynamic tube.

If it were possible to have a parallel flow and an even velocity throughout the whole cross-section, and if the static tube could be placed so as to indicate the true static pressure in the pipe, the dynamic tube placed at a single point in the cross-section would indicate the velocity of the flow in the pipe.

This is not the case, however, because the velocity of the flow in a pipe is not the same throughout the whole cross-section and it is not necessarily at all points, parallel to the walls of the pipe. Due to this fact the application of the single opening Pitot tube involves the searching of the flow by the dynamic tube at various points of the cross-section. This is usually termed the running of a traverse across the diameter. It is also necessary that the static pressure should be transmitted by a pisometer, which is a pressure pocket connected by small openings to the inside of the pipe, and to which the static tube is attached.

There are several methods of running a traverse with a Pitot tube through a given size pipe, and of averaging the results from the readings of the differential pressure. One method is to take the readings, say, 1 inch apart across the diameter, and to multiply each reading by the area of the annular ring which it represents. The further the reading is taken from the center of the pipe, the more area of flow it would represent because the area of a concentric ring of a given width increases with the distance from the center.

Another method is to lay out on co-ordinate paper the square root of each reading against the distance from the center of the pipe of the dynamic tube. From the curve joining the points, the mean velocity of the whole cross-section is graphically determined, and also the distance from the center where the actual velocity is supposed to be the same as the mean velocity in the whole cross-section.

The most accurate method is to divide the pipe into concentric annular rings of equal areas, and to take readings in the center of each ring; the square roots of the readings are averaged for finding the velocity in the pipe. The process of following either method in using the single opening Pitot tube is both tedious and uncertain.

Many technical papers have been written on the subject of Pitot tubes, and all of them are invariably limited to the single opening device. In last year's report made to the American Gas Institute by the Committee on "The Measurement of Gas in Large Volumes," the chapter on Pitot tubes demonstrates the possibilities of the scientific laboratory device for measuring the velocity of gases in pipes. At the beginning of that chapter, the "Pitot Meter" is introduced by the following statement:

"This is the most fascinating of all devices for measuring gas, since the simplicity is attractive and it contains the possibility of being an accurate means of measuring volumes."

After giving the principles of the Pitot tube and fundamental equation, the report continues:

"As a means of measuring gas in large volumes, the method of inserting a Pitot tube in a main in a predetermined position, can merely serve as a rough indication, and may be wrong to the extent of 10, 20, and more per cent. In order to profit by the possibilities of the Pitot tube for accurate measurement, it is necessary to be much more painstaking. The aperture to the static pressure connections must be such that it is not influenced by the flow of the gas current. The pipe should be divided into concentric annular rings and readings made in the center of each ring, and so on."

The difficulty of determining the true static pressure with the single Pitot tube, and the necessity of transversing through the cross-section of the pipe for the various velocities is further demonstrated by the experiments of Mr. W. R. Rowse, quoted in the same report of the committee, the conclusions being that "The process of searching the whole main for impact pressures is quite complicated and gives results that are rather uncertain from the currents, and, although taking a single observation is simpler, it is still more uncertain." This single observation refers to the method of taking readings in the center of the pipe where the velocity has its maximum, and assuming the mean velocity to be a given percentage of this maximum.

The Multi-Opening Pitot Tube.

During the last five or six years successful attempts were made to utilize the principle of the Pitot tube commercially for measuring the flow of gases and liquids. Some concerns have placed on the market indicating and recording flow meters which are actuated by the differential pressure from Pitot tubes inserted in the flow. The progress in this work was due mainly to the development of the multi-opening Pitot tube which eliminates traversing the cross section of the flow and the uncertainties connected with this work.

In the earlier designs of the multi-opening Pitot tubes, the openings of the dynamic tubes were spaced equal distances apart. This was based upon the assumption that when a number of Pitot tubes are equidistantly spaced across one diameter of a circular pipe and all connected together, the dynamic pressure would average up. With such an arrangement for a pipe of say 20-inch radius and 20 dynamic openings, suppose the readings on each side of the center to indicate the corresponding velocities to be as follows:

	Feet per second
First	100
Second	99
Third	98
Fourth	96
Fifth	93
Sixth	90
Seventh	86
Eighth	80
Ninth	70
Tenth	48
	860

The average of these readings is $\frac{860}{10} = 86$ feet per second.

This average does not correspond to the true average of all the velocities in the given cross-section of the pipe, because the areas represented by the openings are not equal. As a result, the experimental coefficient, or the efficiency of such tubes is not a constant quantity, varying with the size or diameter of the pipe. The reason for such variation and corresponding inaccuracy of the tubes is shown by the following argument. The dynamic pressure transmitted by each separate opening is assumed to be the average for an annular ring whose width is say 1 inch. In other words the cross-sectional area of the 20-inch pipe is divided into 10 annular areas, the width of each being 1 inch, and a Pitot tube being located in the center of each. It is easily seen that if the area of the ring at the center of the pipe, which is really a circle 2 inches diameter, is represented by 1, then the area of the second ring is 3, of the third 5, and so on. Therefore, if the average velocity at the center is 100, this velocity should be multiplied by the area of the first ring which if 1 the result in volumes being represented by 100. If the average velocity in the second ring is 99, this velocity should be multiplied by 3, the result in volumes being represented by 297. The proportional volumes delivered through each annular ring is shown in the following table:

Order from center	Velocity	Area referred to center ring unity	Proportional volume through each ring
First	100	1	100
Second	99	3	297
Third	98	5	490
Fourth	96	7	672
Fifth	93	9	837
Sixth	90	11	990
Seventh	86	13	1,118
Eighth	80	15	1,200
Ninth	70	17	1,190
Tenth	48	19	912
			7,806

The total volume delivered by the entire pipe is represented by the sum of all figures in the last column which is 7,806. The average of this which is the true average of the whole cross-section is $\frac{7,806}{100} = 78.06$.

It follows that in the case of the 20-inch pipe and the given velocities the average velocity referred to the area of the cross-section of the pipe is 78.06 while the *Average* of the velocities registered by the tubes which were equally spaced on a single diameter is 86.00.

In general the flow in a given pipe is retarded from the center towards the walls of the pipe in proportion with the perimeter of the flow which represents the amount of rubbing surface. In larger pipes the retardation is not so pronounced as in smaller sizes, and therefore the coefficient of the tubes when the openings are spaced equal distances apart will be different for each size of pipe depending upon the effect of frictional resistance and corresponding retardation of the flow.

Designs of Pitot Tubes.

Fig. 1, shows one of the earlier designs of the multi-opening

Pitot tubes used by the Gebhardt Meter Company. In this tube the projected openings receiving the impact of the flow

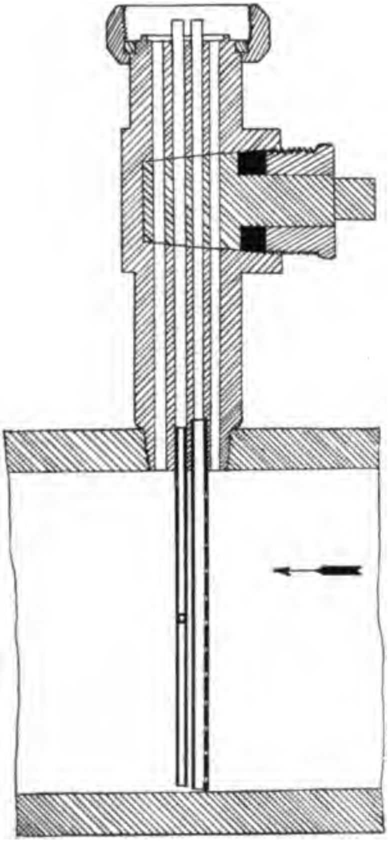


Fig. 1
Gebhardt Multiopening Pitot Tube

are equally spaced across the diameter of the pipe, and the effect of the various impacts is averaged in the dynamic tube from where it is transmitted to the differential gauge or meter. The static tube has several openings facing in many directions, which is done for the purpose of balancing the effect of the flow upon the static tube in order to transmit the true static pressure. The two openings through the tube holder are for clearing the condensation when the tube is used for measuring steam.

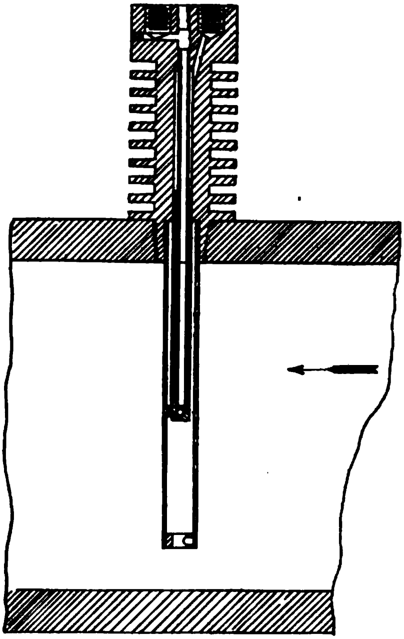


Fig. 2

General Electric Multiopening Pitot Tube

Fig. 2, shows an elaborate design of a multi-opening Pitot tube used by the General Electric Company. In this device the outer tube receives the impact of the flow through the leading set of openings, which are spaced equal distances apart across the diameter of the pipe. The dynamic pressure is averaged in the outer tube and through the intermediate tube is transmitted to the meter or differential gauge. The inner tube receives the static pressure through the trailing set of openings, and this pressure is slightly diminished by the syphoning effect of the flow upon the openings. This effect added to the impact of the flow, slightly increases the indicated differential pressure. When the tube is used for measuring the flow of steam the excessive condensation is drained through the trailing set of openings, and the water of condensation is kept at the same level in the inner and outer tubes due to the concentric arrangement of the tubes.

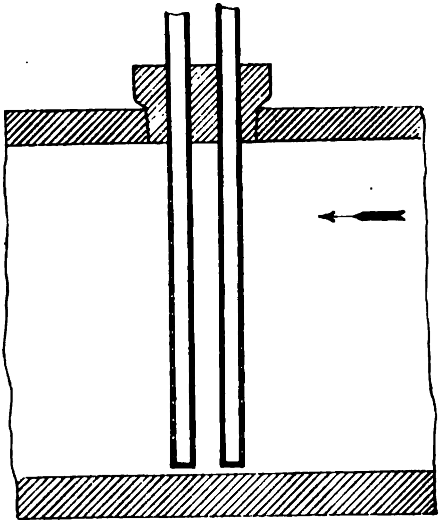


Fig 3
Duplicate Pitot Tube

Fig. 3, shows a multi-opening Pitot tube in which the static tube is an exact duplicate of the dynamic tube. The two tubes are placed in the pipe with the openings 180 degrees apart so that either one may be the dynamic tube, the other producing a suction which increases the differential pressure considerably.

The Equal Area Pitot Tube.

From the foregoing discussion it can be readily seen that when the openings of the tubes are spaced equal distances apart across the diameter of the pipe, the impact of the flow is

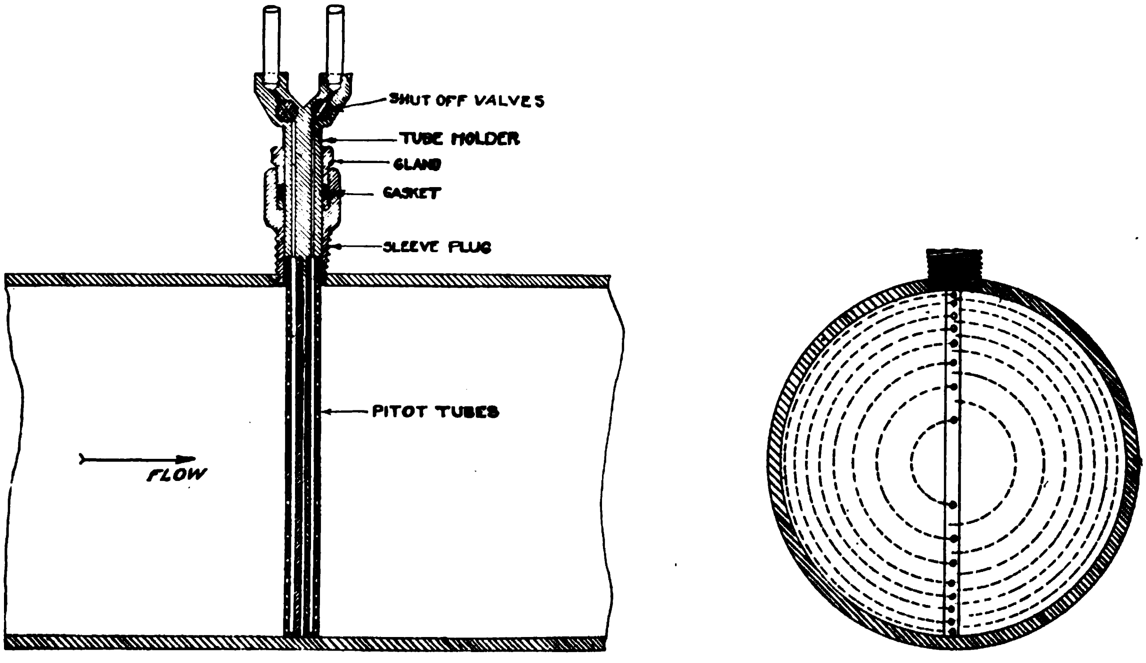

SHUT OFF VALVES
TUBE HOLDER
GLAND
GASKET
SLEEVE PLUG
PITOT TUBES
FLOW
EQUAL AREA RINGS

FIG. 4

not properly represented by the differential pressure. That is while the differential pressure represents the average of the several impacts exerted upon the openings of the tube, this average does not represent the true average velocity throughout the whole cross-section of the pipe, because the areas represented by the openings are widely different.

In order to represent the true average velocity in the whole cross-section of the pipe it is necessary that the openings receiving the impact should represent equal areas of flow. This condition is attained by the equal area Pitot tube shown in Fig. 4. In this tube the openings are placed at such distances from each other that the areas of the annular rings are equal, while the width of each ring is necessarily different. It can be easily shown that if the distance from the center of the pipe to the first opening is 1, then the distance from the center of the pipe to the second openings is $(3)^{1/2}$, to the third $(5)^{1/2}$, and so on.

Those who have experienced running traverses with Pitot tubes will appreciate the ease and accuracy with which the same results are obtained by the use of the equal area Pitot tube. The tube is introduced through a stuffing box until it reaches the opposite wall of the pipe, and when the tube is in that position, each opening falls in center of an equal area concentric ring.

Spacing of Openings.

In the design of the equal area Pitot tube, the proper spacing of the openings is determined from the following calculation:

Let r_1, r_2, r_3, represent the distance from the center of the pipe to the successive openings on both sides of the center.

Let R be the inside radius of the pipe; N, the total number of openings in the Pitot tube.

We have the area of the whole cross-section equal to πR^2, and the portion of area represented by a single opening equal to

$$\frac{\pi R^2}{N}.$$

Since there are two openings in each concentric ring, therefore the area of the circle whose circumference crosses the first pair of openings is equal to one-half of two portions, or $\frac{\pi R^2}{N}$; the area of the circle whose circumference crosses the second pair of openings is equal to three portions, or $\frac{3\pi R^2}{N}$; the third pair is crossed by a circle enclosing five portions, or equal to

$$\frac{5\pi R^2}{N}, \text{ and so on.}$$

The corresponding areas can also be represented by πr_1^2, πr_2^2, πr_3^2, and so on.

Therefore:

$$\pi r_1^2 = \frac{\pi R^2}{N};$$

$$\pi r_2^2 = \frac{3\pi R^2}{N},$$

$$\pi r_3^2 = \frac{5\pi R^2}{N}.$$

This can be written;

$$r_1 = R\left(\frac{1}{N}\right)^{\frac{1}{2}},$$

$$r_2 = R\left(\frac{3}{N}\right)^{\frac{1}{2}},$$

$$r_3 = R\left(\frac{5}{N}\right)^{\frac{1}{2}},$$

and in general

$$r_a = R\left(\frac{2a - 1}{N}\right)^{\frac{1}{2}} = R\left(\frac{1}{N}\right)^{\frac{1}{2}} \times (2a - 1)^{\frac{1}{2}}.$$

Where a is the number of any opening from the center, and r_a is the corresponding radius, or the distance from the center of the pipe to the given opening.

Having each opening of the tube represent an equal area of the flow, and assuming ten openings to be made on each side of the center in a 20-inch pipe, the condition may be represented as follows:

Order from center	Velocity	Radius of ring referred to center as 1	Area referred to center ring as unity	Proportional volume through each ring
First	100	1	1	100
Second	98	$(3)^{1/2}$	1	98
Third	95	$(5)^{1/2}$	1	95
Fourth	90	$(7)^{1/2}$	1	90
Fifth........	86	$(9)^{1/2}$	1	86
Sixth	81	$(11)^{1/2}$	1	81
Seventh	79	$(13)^{1/2}$	1	75
Eighth	67	$(15)^{1/2}$	1	67
Ninth	56	$(17)^{1/2}$	1	56
Tenth	33	$(19)^{1/2}$	1	33
				781

Now the average of the velocities is $\frac{781}{10} = 78.1$ which also is the true average velocity of the whole cross-section.

In the equal area tubes the static tube is an exact duplicate of the dynamic tube, the openings being 180 degrees apart, so that either may be the dynamic tube, the other producing a suction acting to increase the head transmitted to the differential gauge.

The Coefficient of the Equal Area Pitot Tube.

A number of exhaustive tests were made at the Armour Institute of Technology for determining the coefficient of the equal area Pitot tube. The tests were made by comparing the readings of the equal area tube, inserted into an air blast pipe, with those obtained by carefully traversing the pipe for various velocities of the air.

It was found invariably that when the flow through the pipe was more or less evenly distributed, that is when maximum velocity occurred at the center of the pipe, the pressure difference indicated by the equal area Pitot tube was about 55 per cent. higher than the average of the traversing tube.

Comparing the velocity indicated by the differential pressure with the actual velocity in the pipe, it was shown that the coefficient of the equal area Pitot tube is approximately 0.80; that is the actual velocity of the air in the pipe is 80 per cent.

of the velocity equivalent to the differential pressure transmitted by the tube. When the flow of air through the pipe was disturbed considerably, that is when the maximum velocity did not occur in the center of the pipe, the differential pressure transmitted by the tube for a given velocity was greatly diminished. In some of the tests when the flow was much disturbed, the coefficient of the tube increased to 87 per cent.

Tests at Armour Institute of Technology.

The following data is taken from tests conducted by Prof. A. H. Anderson of the Armour Institute of Technology, and shows one test in which the coefficient of the tube figured the minimum value of 78 per cent., and one in which the coefficient, compared with an irregular shape of traverse, as high as 87 per cent.

DATA AND RESULTS OF PITOT TUBE TESTS.

Test No. 7.—Inside diameter of pipe 11.8″. Air temperature at tubes 80° F. Barometric pressure inches hg. 29.5. Average static pressure inches hg. abs. 29.6. Mean velocity in pipe 27.04′ per second.

Reading from Traverses.

Position	Distance from center	Velocity head; inches of water Up	Down	$(h)^{1/2}$ up	$(h)^{1/2}$ down	$(h)^{1/2}$ average
1	1.32	0.18	0.18	0.424	0.424	0.424
2	2.28	0.18	0.18	0.424	0.424	0.424
3	2.95	0.18	0.18	0.424	0.424	0.424
4	3.49	0.17	0.18	0.412	0.424	0.418
5	3.96	0.16	0.18	0.400	0.424	0.412
6	4.38	0.15	0.17	0.387	0.412	0.400
7	4.76	0.15	0.17	0.387	0.412	0.400
8	5.12	0.14	0.15	0.374	0.387	0.380
9	5.45	0.135	0.15	0.367	0.387	0.376
10	5.75	0.09	0.10	0.300	0.316	0.308

Average $(h)^{1/2} = 0.397$

Velocity head transmitted by

Equal area Pitot tube, $h = 0.26$ $(h)^{1/2} = 0.5099$

Coefficient of tube, $C = 0.397/0.5099 = 78$ per cent.

Test No. 11.—Inside diameter of pipe 11.8″. Air temperature at tubes 75° F. Barometric pressure inches hg. 29.7. Average static pressure inches hg. abs. 29.95. Mean velocity of air in pipe 55.78 per second.

Reading from Traverses.

Position	Distance from center	Velocity head; inches of water		$(h)^{1/2}$	$(h)^{1/2}$	$(h)^{1/2}$
		Up	Down	up	down	average
1	1.32	0.80	0.68	0.894	0.825	0.860
2	2.28	0.84	0.64	0.916	0.800	0.858
3	2.95	0.89	0.61	0.943	0.781	0.862
4	3.49	0.91	0.61	0.954	0.781	0.867
5	3.96	0.91	0.60	0.954	0.775	0.864
6	4.38	0.91	0.58	0.954	0.761	0.857
7	4.76	0.90	0.53	0.948	0.728	0.838
8	5.12	0.83	0.49	0.911	0.706	0.808
9	5.45	0.72	0.35	0.846	0.592	0.720
10	5.75	0.57	0.27	0.255	0.519	0.637

Average $(h)^{1/2} = 0.817$

Velocity head transmitted by

Equal area Pitot tube, $h = 0.88$ $(h)^{1/2} = 0.938$

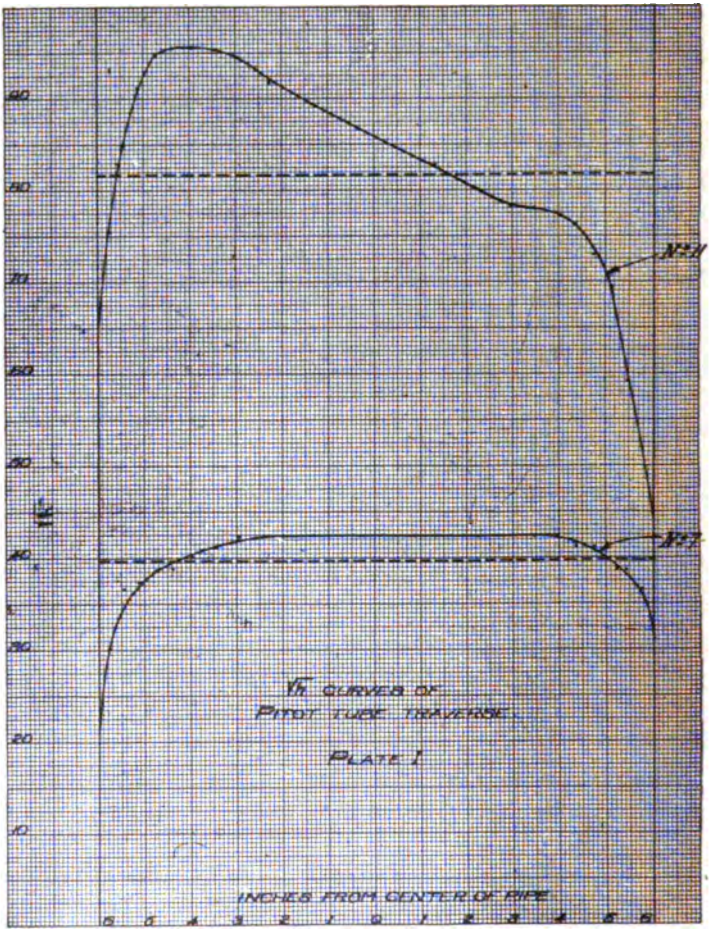
Coefficient of tube, $C = 0.817/0.938 = 87$ per cent.

The accompanying diagram (Plate 1) shows the value of $(h)^{1/2}$ plotted to scale for the traverse reading of the two tests. In test No. 7 the flow of the air was uniformly distributed over the whole cross-section of the pipe, and therefore the readings were considered more reliable than those of the test No. 11, in which the irregularity of the flow is very pronounced.

From the majority of tests in which the flow was more or less uniform, the coefficient of the tube was shown to have an average value of 0.80. Soon after an occasion presented itself to test the equal area tube against a large station meter at the South Station of the Peoples Gas Light & Coke Company in Chicago.

Test Against a Large Station Meter.

For the purpose of the test, the station meter was disconnected from the gas main and a turbine driven centrifugal



$\sqrt{h}$ CURVES OF PITOT TUBE TRAVERSE.

PLATE I

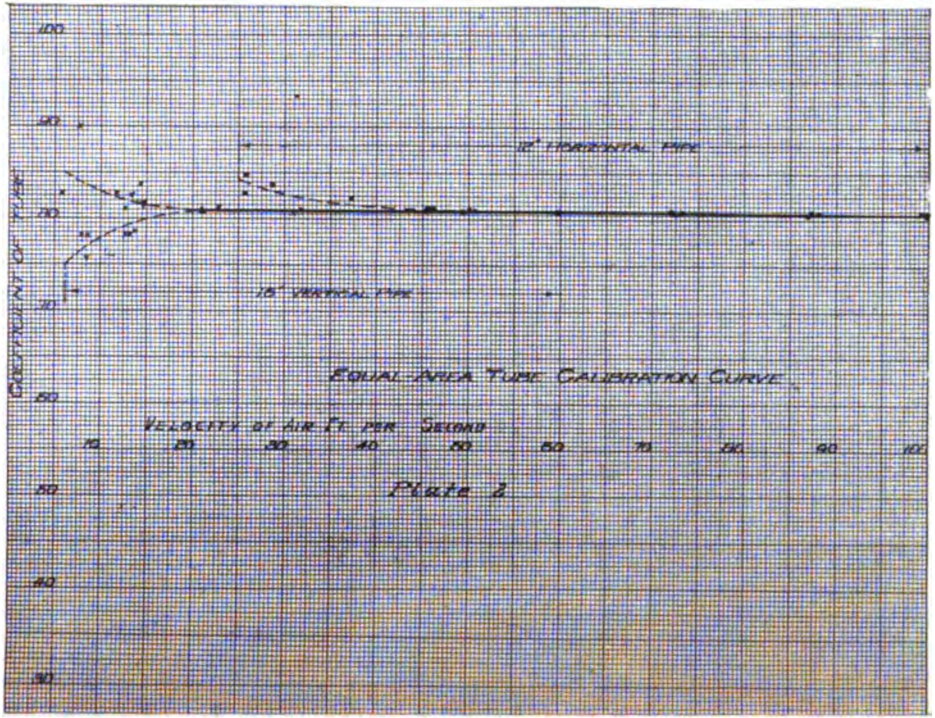
blower was connected to the 30-inch inlet of the meter, while the outlet of the meter was reduced in size to a vertical length of 16-inch pipe, and still another horizontal length of 12-inch pipe after the 16-inch, in order to obtain higher velocities for the test.

The Pitot tube inserted in the 16-inch pipe was connected to a 10 to 1 Ellison inclined differential gauge reading in 1/100 of an inch. The Pitot tube in the 12-inch pipe was connected to a 5 to 1 inclined gauge of the same type. The same quantity of air measured by the station meter was compared with a differential pressure more than three times larger in the 12-inch pipe than in the 16-inch pipe, due to difference in the cross-sectional area of the flow.

The results of the tests are shown on the following diagram Plate 2, in which the small circles indicate points of the 12-inch pipe tests, and the small crosses indicate the same of the 16-inch pipe. It will be noticed that at velocities lower than 20 feet per second on the 16-inch pipe, and lower than 40 feet per second on the 12-inch pipe the value of the coefficient is very irregular. This was explained by the fact that the inclined gauges used for reading the differential pressures were not sensitive enough for the lower readings, where a small difference in pressure corresponded to a large percentage of the flow. From the higher velocities it was shown that the coefficient of the tubes is nearly constant, and it was obvious that for lower velocities more sensitive gauges were required to indicate the differential pressure. This gave rise to the necessity of an inclined differential gauge which should decrease its slope gradually towards the zero reading of the gauge.

The Square Root Differential Gauge.

It was realized that by bending the glass tube to a parabolic shape the sensitiveness of the gauge increases as the head decreases. For instance in a 10 to 1 inclined gauge the scale distance for 0.01 inch head is 1/10 inch. When the glass tube is bent in the parabolic shape the scale distance for the first 1/100



Equal-Area Tube Calibration Curve

Plate 2

of an inch is 1 inch, or 10 times larger than in the 1 to 10 inclined gauge.

An additional advantage of bending the glass tube in the parabolic shape is that the reading indicates directly the square root of the pressure difference corresponding to the velocity or volume of the flow. The construction of the gauge is based upon the following principles.

Principles of the Square Root Differential Gauge.

In all cases where a liquid column is employed to indicate the velocity head or pressure difference in the flow of a fluid, the object is to determine the amount of the flow, or the velocity of the fluid equivalent to the pressure difference or velocity head.

We know from the relation of pressure and velocity that the square of the velocity of the fluid is proportional to the pressure difference or equivalent head. For instance, when the velocity of the fluid is doubled, the velocity head increases four times. This relation is represented by the familiar equation.

$$V^2 = 2gh$$

Where V is the velocity of the fluid in feet per second; g, is the gravity unit of mass, equal 32.2 and h is the velocity head in feet of the given fluid.

When the velocity head is counter-balanced by a liquid column of a given density or weight, the ratio between the density of the fluid and the density of the liquid is a constant quantity; and since 2g is also a constant, we can write the equation

$$V^2 = \text{constant times } h$$

which represents the familiar equation of the parabolic curve.

$$\text{Let } U^2 = \frac{V^2}{\text{Constant}}; \text{ then } U^2 = h.$$

Let U and h be the horizontal and vertical co-ordinates respectively, of a parabolic curve plotted to represent the equation $U^2 = h$. This curve will pass through the following and similar points:

Corresponding values	
Of U	Of h
0.1	0.01
0.2	0.04
0.3	0.09
0.4	0.16
0.5	0.25
0.6	0.36
0.7	0.49
0.8	0.64
0.9	0.81
1.0	1.00

It is obvious that when the glass tube of a differential gauge is laid out in the shape of the parabolic curve, the values of U and h are bound to correspond with each other; that is, the vetrical drop h is equal to the square of the horizontal displacement U, or $h = U^2$ and *vice versa*, the horizontal displacement U is equal to the square root of the vertical drop, or $U = (h)^{1/2}$.

Details of the Square Root Gauge.

The details of the square root gauge, constructed on the above principle, is shown in Fig. 5. The glass tube is attached to an aluminum casing, and is curved from left to right to such an extent that the successive vertical drop is increased proportionally with the square of the horizontal divisions on the scale of the gauge.

The vertical drop is laid out to a natural scale. For the horizontal divisions a base of 10 inches is used for the first unit. After the first unit the scale is gradually reduced to zero, where the tube turns straight downwards. In this gauge therefore the divisions on the scale represent units of velocity, or volume of the flow, since each unit is equal to the square root of the corresponding vertical drop or head equivalent to the given velocity.

For general purposes the scale of the square root differential gauge is laid out to a base of 1 inch of water; that is, each mark on the scale represents the given multiple of a flow equivalent

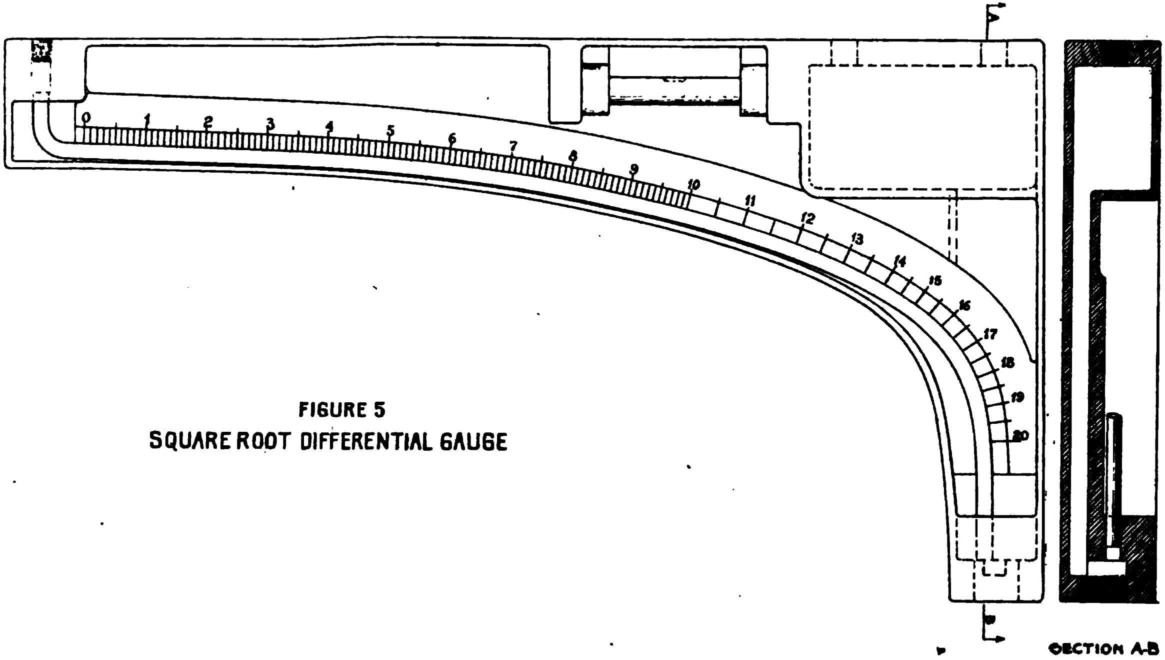


FIGURE 5
SQUARE ROOT DIFFERENTIAL GAUGE

to 1 inch of water head. For instance, 1 on the scale represents 1 times the flow equivalent to 1 inch of water head, and 0.1 on the scale represents 0.1 of the flow equivalent to 1 inch of water head, which if referred to the magnitude of the head would be the flow equivalent to 0.01 inch of water head.

When the gauge and Pitot tubes are set for a given condition, the scale can be made to read in cubic feet of gas directly, by including the necessary factors in the graduation of the scale.

The Construction of the Scale.

The calculations involved in the construction of the scale for the square root differential gauge are as follows:

Let: V = Velocity of gas in feet per minute at the cross-section where the Pitot tube is inserted.

D = Inside diameter of pipe in inches.

t_1 = Temperature of gas degrees Fahrenheit.

B_1 = Absolute pressure in pipe, inches of mercury.

Q_1 = Volume of gas in cubic feet per minute flowing through the pipe at temperature t_1, and absolute pressure B_1.

h = Pressure difference in inches of water transmitted from the Pitot tube to the differential gauge.

U = Reading of scale on square root gauge in units of flow.

S = Specific gravity of gas referred to dry air.

y_1 = Density of dry air in pounds per cubic foot at temperature t_1 and absolute pressure B_1; therefore the density of the gas is Sy_1 pounds per cubic foot.

C = Experimental coefficient for the given instrument.

It can be shown that the velocity of the gas is determined from the equation

$$V = 1{,}098\,C\left(\frac{h}{Sy_1}\right)^{\frac{1}{2}}. \qquad \text{Equation (1)}$$

Since $U = (h)^{\frac{1}{2}}$, therefore equation (1) can be written

$$V = 1{,}098\,CU\left(\frac{1}{Sy_1}\right)^{\frac{1}{2}}. \qquad \text{Equation (2)}$$

The density of dry air at 60° F. and 30 in. barometer is approximately 0.0764 pound per cubic foot. At any temperature t_1 and pressure B_1

$$y_1 = 1.325 \frac{B_1}{460 + t_1}. \qquad \text{Equation (3)}$$

With this value of y_1, equation (2) can be written:

$$V = 1{,}098\ CU \left(\frac{460 + t_1}{1.325\ B_1S}\right)^{1/2}, \qquad \text{Equation (4)}$$

or

$$V = 954\ CU \left(\frac{460 + t_1}{SB_1}\right)^{1/2}, \qquad \text{Equation (5)}$$

and

$$Q_1 = \frac{0.7854\ D^2V}{144} = 5.2\ D^2\left(\frac{460 + t_1}{SB_1}\right)^{1/2} \times CU. \qquad \text{Equation (6)}$$

For any given condition, D is a constant quantity, t_1 B_1 and S are practically the same, so that Q is equal to a constant quantity times U. For instance, let $D = 20$ in., $t_1 = 80°$ F., $B_1 = 30.5$ in. of mercury, $S = 0.65$; then

$$Q_1 = 5.2 \times 400 \left(\frac{540}{0.65 \times 30.5}\right)^{1/2} CU = 10{,}850\ CU.$$

Assume that C is equal to 0.80, then

$$Q_1 = 8{,}680\ U.$$

In equation (6) Q_1, represents the volume of the gas at actual conditions of pressure and temperature. If the volume Q at standard conditions of 30 and 60° F. is desired, Q_1 has to be corrected for pressure temperature and water vapor the same as volumes indicated by a displacement meter. These corrections can be made by inserting the necessary factors into equation 6. If the gas can be considered dry as is usually the case with natural gas

$$Q \times \frac{30}{460 + 60} = Q_1 \times \frac{B_1}{460 + t_1}. \qquad \text{Equation (7)}$$

Combining equations (6) and (7) we have

$$Q = 90.15\ D^2 \left(\frac{B_1}{S\ (460 + t_1)}\right)^{1/2} CU. \qquad \text{Equation (8)}$$

in which Q is the volume of gas in cubic feet per minute at standard conditions of 30 and 60.

Testing Pitot Tubes and Square Root Gauge.

The design and the development of the square root differential gauge involved many difficulties which had to be overcome before its use could be adopted for practical purposes. The bending of the glass tube to follow the exact theoretical shape of a parabola was a difficult problem. For the calibration of the gauge, a special pressure regulator and gauge tester had to be constructed in order to take care of the exceedingly low pressures on the horizontal part of the parabola.

Before the final design of the gauge was completed, and while the necessary forms and models were being changed and improved, a few samples had been prepared and sent to the members of the committee for the purpose of performing the necessary testing during the process of development. Following are the results of the tests completed to date:

Equal Area Pitot Tube and Square Root Differential Gauge Tested at Station "A," Philadelphia Gas Works.

By Mr. P. T. Dashiel.

Location.—The tubes were inserted in the side of a 36-inch cast iron main in which the flow of gas was vertically downwards. The location of the tube was about 12 feet after a 90 degree bend in the direction of the flow. The gas passing through the main during the test was a mixture of coal and water gas, about half and half, with a specific gravity of 0.60.

The gauge was located about 12 feet above the location of the tubes and was connected by ¼-inch standard pipes and short lengths of rubber tubing made perfectly air tight.

The Test.—One hour constituted the duration of each individual test. Before starting, the indication of the red liquid in the square root tube was made to correspond with the zero of the scale with atmospheric pressure on both sides. After the liquid had come to rest (which required at least 15 minutes or more) the rubber leads from the square root gauge were connected up to the respective leads from the Pitot tubes and readings of the gauge were taken constantly during the progress of the test; also reading of station meter, and observation of pressures and temperatures were made.

The indication of the square root gauge did not vary more than one division, except during the last 5 or 10 minutes of the hour, when it showed decided unsteadiness. This was entirely foreign to the instrument, however, being due to a change in the exhauster speed in order to maintain the relief holder at the same point from hour to hour. This caused a variation of not more than two divisions.

From these readings an average was obtained which together with the quantity of gas as read on the station meters, was inserted in equation (6) and the latter solved for the coefficient of the tube. At the end of this report will be found sample calculations for case No. 1.

Data and Results of Test.

Inside diameter of pipe 36 in. Average temperature of gas 84° F. Average static pressure 30.78 in. of mercury. Specific gravity of gas 0.60.

	Cu. ft. of gas per minute	Velocity of gas; feet per second	Theoretical head in inches of water	Readings sq. rt. diff. gauge	Experimental coefficient
1	4,666	11.0	0.0161	0.200	0.647
2	4,900	11.5	0.0176	0.200	0.668
3	5,033	11.9	0.0189	0.205	0.675
4	5,233	12.3	0.0202	0.210	0.685
5	5,350	12.6	0.0212	0.220	0.656
6	5,800	13.7	0.0265	0.230	0.690
7	6.000	14.1	0.0281	0.235	0.698
8	5,250	14.7	0.0304	0.240	0.713
9	6,316	14.9	0.0313	0.245	0.705

Average, 0.681

Discussion of Results—Accuracy.—Due to the fact that the parabolic tube is practically horizontal at the zero mark, great care and extraordinary patience is required to adjust the level of the liquid and make it coincide with zero. The liquid is exceedingly slow in its movement at this point. If the gauge is not allowed to stand and settle for fully 20 minutes, there is great danger of starting with a false zero.

However, since the zero mark of the gauge is on the horizontal part of the parabolic tube, a little space either way does not matter much, because there is practically no vertical difference involved. In extremely low velocities, as in the case of this test, the zero reading would have to be absolutely correct. From the fact that the nine coefficients obtained in this test have a tendency to rise at higher velocities, it seems that if the gauge had a column of one hundredth of an inch higher at the start the coefficient would have been equalized to an approximate value of 0.77. That is, the correction would effect the lower readings to a larger extent than the higher readings, so that it would have made the coefficient constant.

In this particular instrument, the glass had several elevations or humps in it, such as occur in any bent glass tube when not bent with care. These irregularities occurred in a part of the tube which was always filled with liquid throughout the test, and consequently did not seriously interfere with the value of the results obtained, but are unnecessary source of probable error, which should be eliminated in the final design of the gauge.

The graduations of the scale of the gauge were also very imperfect, which probably have resulted in additional inaccuracy in the readings, and which should also be eliminated in the final design of the gauge.

The Pitot tubes gave seemingly consistent readings when they were not filled with water. Frequently during the hour's run it was necessary to disconnect the quarter inch leads and pull the tubes from the main to clean them of adhering moisture in order to get satisfactory readings. Blowing out the tubes did not seem to remedy the trouble. After the tubes were replaced the gauge would come back to its previous reading until more water collected, when it would again show signs of water by slowly moving back to zero.

This was due to the fact that the tube formed a pocket, and no drain was provided for the accumulated moisture. This trouble was never experienced on the down stream side, the Pitot tube remaining perfectly clear.

Value of Results.—As previously noted, the test for values of quantity around 300-400,000 cubic feet per hour in the 36-inch pipe gave a coefficient for the tubes of about 0.68. This was determined by plotting the values of the gauge readings as abscissa and the square root of the velocity head as ordinates for the various points. The slope of the curve drawn through these points gives the coefficient.

This, however, is at almost the lowest point at which the gauge can be read, and also the point which is most liable to error. The gauge can only be read accurately to within one-half the division, which is equivalent of about 11,000 cubic feet. This, on the basis of 350,000 cubic feet per hour, is an error of over 3 per cent.

It is worthy of note that although the Pitot tubes were taken out and put back several times, it did not interfere appreciably with the value of the coefficient.

In summarizing, the instrument is a very convenient and fairly accurate way of arriving at gas quantities, provided the tendency which the Pitot tubes have of accumulating water is overcome and the bore and shape of the glass parabolic tube is made so that there will be no appreciable error in the readings.

Sample Calculation for Case No. 1.

Data

U, Sq. Ft. Diff. Gauge reading = 0.200.
t_1, Temperature: Water 86° F. Coal 83° F.
P, Pressure = 10.6 water.
B, Barometer = 30.0″ Hg.
S, Specific gravity = 0.60.
D, Pipe diameter = 36″.
B_1, abs. pressure in inches mercury B 0.0737 P.
C, Coefficient.

$$Q_1 = 5.2 \times D^2 \left(\frac{460 + t_1}{SB_1}\right)^{\frac{1}{2}} CU \qquad \text{Equation (6)}$$

from which
$$C = 0.192 \frac{Q_1}{U\,D} \left(\frac{SB_1}{460 + t_1}\right)^{\frac{1}{2}} =$$

$$\frac{0.192 \times 4{,}666}{0.2 \times 1{,}296} \left(\frac{0.6 \times 30.7}{544}\right)^{\frac{1}{2}} = 0.647.$$

Equal Area Pitot Tube and Square Root Differential Gauge Tested at Williamsburgh Works Brooklyn Union Gas Company, By Mr. Van Allen Clark.

Location.—The location of the Pitot tube in the 20-inch pipe which forms the outlet from No. 1 station meter is shown on the accompanying drawing No. 6. Water gas with a specific gravity of about 0.67 is passing through the pipe and the flow of gas at this point is vertically downwards. The gauge was attached firmly in front of the 20-inch pipe at a distance of about 4 feet above the tubes, and was connected to the tubes by means of ¼-inch standard pipe and short lengths of rubber tubing.

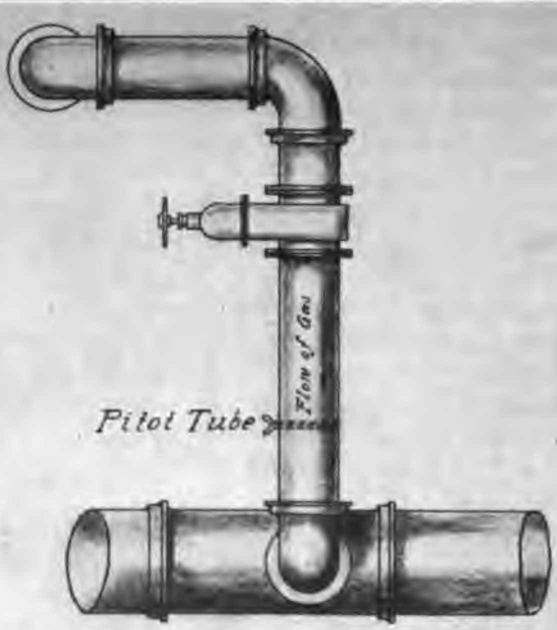


Fig. 6
Location of Pitot Tube in 20" Gas Main

The Test.—The test consisted of 13 individual runs of nearly 1 hour each. The runs were made on 3 different days, and at varying rates of flow, which were obtained by diverting gas from other meters. During each test, readings of the square root gauge were taken every 30 seconds and the average was figured as the mean for the run. The exhausters were set so as to give nearly constant flow, and the test was continued until a change in the rate of flow became necessary. The temperatures and pressures did not change materially during any of the runs. The station meter was read at intervals of 5 minutes to give a check on the uniformity of the gas flow.

The specific gravity was determined by the diffusion method from samples of gas taken at the meter outlet, once during each run. The Schilling apparatus was employed, and determinations were made against air, over water. This does not give the figure of specific gravity referred to dry air. The correction, however, for the given temperatures is so small (0.005) that it could easily be neglected.

The results of the test are given in the following table:

	Duration of run minutes	Cu. ft. of gas per minute	Velocity of gas feet per second	Theoretical head inches of water	Reading of gauge scale	Gas temperature degrees Fahrenheit
		Q	V		U	T
1	60	1,540	11.8	0.021	0.1900	70
2	60	1,875	14.3	0.031	0.2140	70
3	63	2,004	15.3	0.035	0.2310	70
4	69	2,206	16.8	0.042	0.2490	82
5	68	2,723	20.8	0.065	0.3017	82
6	45	2,816	21.4	0.069	0.3140	82
7	48	3,057	23.3	0.081	0.3360	82
8	54	2,411	18.4	0.051	0.2700	78
9	60	2,898	22.1	0.073	0.3210	78
10	40	3,219	24.5	0.090	0.3455	78
11	62	3,113	23.7	0.084	0.3430	78
12	54	3,223	24.6	0.091	0.3560	78
13	48	3,298	25.2	0.095	0.3620	78

	Gas pressure inches of water P	Barometer inches of mercury B	Absolute pressure inch mercury B1	Specific gravity of gas S	Experimented coefficient C
1	5.4	29.89	30.29	0.676	0.7631
2	5.4	29.89	30.29	0.676	0.8253
3	5.4	29.89	30.29	0.676	0.8175
4	5.8	30.20	30.63	0.661	0.8231
5	5.8	30.20	30.63	0.661	0.8381
6	5.8	30.20	30.63	0.661	0.8334
7	5.8	30.20	30.63	0.661	0.8451
8	9.8	30.11	30.83	0.672	0.8422
9	9.8	30.11	30.83	0.672	0.8528
10	9.8	30.11	30.83	0.672	0.8800
11	6.4	30.11	30.58	0.672	0.8535
12	6.4	30.11	30.58	0.672	0.8495
13	6.4	30.11	30.58	0.672	0.8558
				Average,	0.8369

The value of the coefficient C was determined by the equation:

$$C = 0.192 \frac{Q}{U} D^2 \left(\frac{SB_1}{460 + t_1}\right)^{½}, \qquad \text{Equation (9)}$$

and the theoretical velocity head in inches of water was determined from the equation.

$$h = \frac{00397\ V^2SB_1}{460 + t_1}, \qquad \text{Equation (10)}$$

where V is the velocity in feet per second.

Discussion of Results.

The average value of the coefficient from the 13 individual tests is 0.8369. With the exception of one test, the coefficient did not vary much from the average value. The readings were all taken at low differentials, the maximum velocity head obtained figuring less than one-tenth of an inch of water, while the minimum was as low as two one-hundredths of an inch.

There seems, however, to be a tendency for the coefficient to drop at the smallest rates of flow, and if a curve were drawn following the direction of these points, and extended, it would show an intercept on the horizontal axis. This may be attributed partly to the effect of capillarity of the tube, which is very nearly horizontal at the points of low scale readings. For this reason there seems to be a question as to the value of the coefficient for velocities of gas, say lower than 12 feet per second. The results obtained when the velocities were higher, show very consistant figures. The Pitot tube is essentially a velocity pressure instrument, and it could hardly be expected that it should be equally accurate at velocities which produce differentials of less than two one-hundredths of an inch of liquid, even using the parabolic scales. With the ordinary inclined gauge glass the use of such low differentials is, of course, out of the question. It is very essential that the glass should conform to a true parabolia.

There was difficulty experienced in keeping the dynamic tube free from condensation. The gas following downward seemed to seal off a portion of this tube, and could not be removed by blowing out the lines. It was necessary to remove the tube every half hour to shake the water out of it.

The construction of the tube is such that when used in a vertical pipe with downward flow, the condensation accumulates in the dynamic tube, and there are no means of draining it back into the pipe. The alteration in the connections to permit a drainage at the same level as the tube in the pipe might overcome this difficulty. With this exception, the instrument seems to be a reliable and satisfactory device, with the added advantage of extreme simplicity. When completed, it will unquestionably be a valuable adjunct to gas works.

Equal Area Pitot Tube and Square Root Differential Gauge Tested at Station A, Laclede Gas Light Company.

By Mr. H. C. Wehnert.

The tubes were inserted in the side of a 20-inch cast iron pipe vertical in position, which forms the outlet gas main of an 11 foot Hinman drum station meter. It was placed 5 feet 6 inches after a 90 degree bend, and 12 inches ahead of a valve, and 6 feet 0 inch ahead of a tee. The square root differential gauge was mounted on a wall near by and levelled by means of an adjusting screw.

One-quarter inch pipe was run from the Pitot tubes to the square root differential gauge, connections to the gauge being made by short lengths of rubber tubing, securely wired to the air cock connections on the gauge to prevent leaks.

The Test.—Before starting the test, the red liquid was poured into the gauge, and adjusted until it was exactly at zero, with atmospheric pressure on both sides. The gauge was then connected to the tubes.

The tubes were tested by a station meter measuring water gas. Ten individual runs were made, the time period of each run being of 10 minutes duration. It was found that with a short test period, the indication on the gauge could be maintained with the least variation. It was endeavored to maintain a constant flow during each run.

DATA AND RESULTS OF TEST.

Inside diameter of pipe 20 in. Average temperature of gas 84° F. Average static pressure 30.16 in. of mercury. Specific gravity of gas 0.733.

	Cu. ft. per minute	Velocity of gas feet per second	Theoretical head; inch of water	Readings sq. rt. diff. gauge	Experimental coefficient
1	905	7.01	0.0081	0.095	0.938
2	1,242	9.61	0.0152	0.136	0.934
3	1,312	10.16	0.0167	0.148	0.872
4	1,415	11.51	0.0217	0.175	0.796
5	1,630	12.63	0.0262	0.198	0.810
6	1,720	13.33	0.0292	0.210	0.806
7	1,849	14.33	0.0338	0.222	0.820
8	1,870	14.49	0.0344	0.224	0.821
9	1,900	14.72	0.0356	0.228	0.820
10	2,117	16.41	0.0442	0.247	0.843
				Average,	0.846
				Average last 7 runs,	0.817

The readings of the gauge were taken every minute and averaged for each run. Readings of pressures and temperature were taken during each run. The specific gravity of the gas was determined by comparison of weights of equal volumes of dry air and dry gas at the temperature of the gas at the Pitot tubes. Two determinations were made and found to be 0.732 and 0.734. An average of the two readings, or 0.733, was taken as the specific gravity of the gas.

The data collected for each test was substituted in equation (6) and the latter solved for the coefficient of the tube.

Discussion of Results.—It was endeavored in the above test to determine the value of the coefficient for extremely low velocities, and although painstaking care was used in reading the gauge, a possible error may have been made by not reading the gauge correctly. In the first place, the curvature of the scale did not correspond with the curvature of the glass. At the zero point the scale was fully ¼ inch from the glass tube, whereas for the higher readings, the scale was directly in line with the glass tube. For correct indications, the scale as well as the glass tube should be parabolic in shape, and should correspond with each other.

The scale was not subdivided between the points 0.100 and 0.200 and the indications were taken in proportional parts, which no doubt introduced another error for indications between these points. The whole scale on this gauge was not evenly subdivided, some divisions being one and one-half times as large as others. This was due to the fact that the glass tube in the first samples did not have the true parabolic shape.

The effect of these imperfections in the gauge, which was used during this test, is most noticeable in the results of the first three runs, in which the flow was extremely low. In the first run, the theoretical velocity head was less than one-hundredth of an inch, and all three runs were below two one-hundredths of an inch. Taking the average of the other seven runs, the value of the coefficient is reduced from 0.846 to 0.817. This value will probably result also for the very low readings after the scale of the gauge is perfected.

There was no trouble experienced from condensation collecting in the up stream or dynamic tube. The tube was frequently removed to see whether water had collected, but very little water was found, and when replaced, the indications were practically the same.

The equal area Pitot tube and square root differential pressure gauge no doubt is a fairly accurate instrument for measuring large volumes of gas. It could be used to advantage for checking the station meter at higher velocities, if the scale should be perfected to check with the station meter also for lower velocities.

Equal Area Pitot Tube and Square Root Differential Gauge Tested at Division Street Station, The Peoples Gas Light & Coke Company.

By Mr. G. B. Landes.

The square root differential gauge used in this test is a marked improvement over all gauges used on previous tests. The glass tubes in former gauges were bent by hand and consequently they were all more or less irregular. This made it impossible to make accurate readings of differential head, especially at the lower velocities. In the gauge as now made, the tube is shaped by means of a steel dye. It conforms to a true parabolic curve and the scale graduations have been laid off with great care and precision.

Location.—The tubes were inserted in the top of a 36-inch horizontal overhead main. This main is the inlet to the meters —the gas passing through it is entirely water gas—and is afterwards distributed among four Hinman drum station meters. The tubes were placed about 15 feet after a 90 degree bend and 10 feet ahead of a tee.

The gauge was located on the wall beneath the main, connections with the tube being made of ¼-inch pipe. In this case no rubber tubing was used, the connections being entirely of metal. The location and arrangement of tubes and gauge is shown on accompanying sketch, Fig. 7.

The test: Before starting, the gauge was carefully leveled and the liquid adjusted to the zero mark. Two distinct tests were run. The first covered a period of 17 days and was divided into 17 tests of 24 hours each. Readings of the gauge were taken every 10 minutes and of the meters every hour. The object of this test was not only to determine the experimental coefficient, but to make a study of the reliability of the tubes and gauge to perform their mechanical functions correctly day after day.

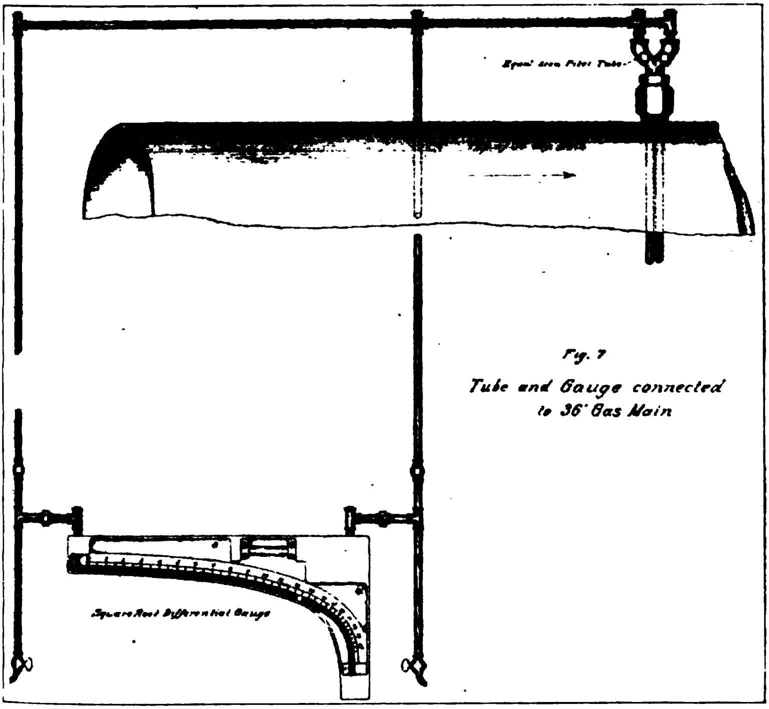


Fig. 7
Tube and Gauge connected to 36" Gas Main

In the second test, gauge readings were taken every 30 seconds over 10 minute periods. The meters were read at the beginning, at 5 minutes and at the end of each test.

The gauge pressures were taken by means of an ordinary U-tube gauge on the meter inlet.

The temperatures were taken by means of an angle stem thermometer in the meter outlet.

Diffusion tests for specific gravity were made from time to time during the test. As the variations were very small, an average of 0.675 was determined and used in all calculations.

RESULTS OF LONG PERIOD TESTS.

Inside diameter of pipe 35⅞ in. Average temperature of gas 80° F. Average static pressure 30.00 in. mercury. Specific gravity of gas 0.675. Long period tests (24 hours each.)

Test	Cu. ft. of gas per minute	Velocity of gas; ft. per second	Reading of gauge scale	Experimental coefficient
1	7,973	18.9	0.2931	0.7860
2	8,017	19.0	0.3005	0.7710
3	7,776	18.4	0.2774	0.8100
4	7,975	18.9	0.2888	0.7975
5	7,873	18.7	0.2867	0.7935
6	7,808	18.5	0.2814	0.8020
7	6,180	14.7	0.2318	0.7705
8	5,822	13.8	0.2110	0.7970
9	7,483	17.8	0.2608	0.8285
10	7,626	18.1	0.2887	0.7625
11	9,696	33.0	0.3520	0.7965
12	10,270	24.4	0.3717	0.7995
13	10,150	24.1	0.3760	0.7810
14	7,888	18.7	0.2894	0.7885
15	6,171	14.7	0.2183	0.8175
16	7,798	18.5	0.2912	0.7740
17	7,803	18.5	0.2929	0.7710
			Average,	0.7901

RESULTS OF SHORT PERIOD TESTS.

Inside diameter of pipe 35⅞ in. Average temperature of gas 86° F. Average static pressure 30.04 in. mercury. Specific gravity of gas 0.675.

Test	Duration of run minutes	Cu. ft. of gas per minute	Velocity of gas per ft. per sec.	Reading of gauge scale	Experimental coefficient
1	10	5,920	12.6	0.1953	0.7788
2	10	9,110	21.6	0.3394	0.7710
3	5	8,120	19.3	0.2997	0.7788
4	5	8,190	19.5	0.2996	0.7860
5	10	8,190	19.5	0.3023	0.7790
6	10	9,690	22.5	0.3540	0.7870
7	10	11,790	28.0	0.4214	0.8050
8	10	10,900	35.9	0.3945	0.7942
				Average,	0.7850

Discussion of Results.—The averages of the short and long period tests are 0.7850 and 0.7901 respectively.

In the long period tests, the 10 minute gauge readings show quite a variation. This was to be expected as no attempt was made to maintain a constant exhauster speed and the readings were taken at random. However, any errors that might be introduced on account of variable velocities are reduced to a minimum by the great number of readings taken.

Long period tests were obtained of velocities ranging from 13.8 to 24.4 feet per second. The experimental coefficients determined at the lower velocities—say under 18 feet per second—are seen to be much less uniform than those obtained from higher velocities. This shows that the gauge is more accurate at the higher velocities.

In the short period tests, the works exhauster was set for different velocities and care was taken to maintain this velocity as constant as possible during the run. The gauge readings even at the lower velocities showed but a slight variation for each test. A variation in average velocities from 12.8 to 28.0 feet per second was obtained in the short period tests. The experimental coefficient, while fairly constant, shows a tendency to rise at the higher velocities. A probable source of error was introduced into the short period tests by the fact that it was necessary for one man to read the four station meters.

During the entire time that the tube and gauge have been in use they have given no trouble whatsoever. The tubes were inserted in the pipe in a vertical position and no trace of condensation was ever noticed in the connections.

With the gauge in its present state of perfection, readings of differential head can be taken with a great degree of accuracy. This is true even at the lower velocities.

If care is taken to determine the proper experimental coefficient for existing conditions, the equal area Pitot tube and square root differential gauge is no doubt quite a reliable instrument for measuring volumes of gas. This fact together with the simplicity of its application should strongly recommend it for measurement in the gas works.

CONCLUSION.

It may be of interest to note that after the test at Division Street station was completed, the scale of the square root differential gauge was marked off to read directly in cubic feet of gas passing through the 36-inch pipe, and the outfit was left permanently on the line. The advantage of having this outfit is that the rate of flow through all the station meters can be ascertained at any time. If it were necessary to by-pass the station meters, or if one of the meters should happen to become pitted and register erroneous volumes, the gas could always be measured accurately by taking 10 minute readings on the gauge as was done in the long period tests.

The experiments outlined in this report show conclusively that the equal area Pitot tube invariably transmits the true differential pressure equivalent to the average velocity of the whole cross-section of the pipe in which the tube is placed. The report covers the flow of gas and air, but many tests have been made with steam and water, and in every case, the coefficient of the equal-area Pitot tube has been very close to 0.80.

This tube is also used in connection with various commercial meters for measuring the flow of air, gas, steam and water, both of the indicating and recording type. The impact transmitted by the Pitot tube is in some cases utilized by means of floats, in others, by means of diaphragms or Bourdon springs. The most successful instrument, however, utilizes a mercury column and a number of stationary contacts, which vary the flow of an electric current in proportion to the flow of the fluid in the pipe, thus avoiding mechanisms and the attendant lost motion and friction.

Where the velocity pressure amounts to at least 1 inch of water, there is no difficulty in determining it by means of ordinary commercial instruments. One object of this report was to develop a device for indicating accurately exceedingly small velocity heads. This was necessary for the reason that the velocity of gases in pipes and mains is usually very small. It was shown from the tests that velocities corresponding to heads of one-hundredth of an inch or less were read with reasonable accuracy on the square-root differential gauge. An additional feature is that the gauge is equipped with a scale of equally-spaced divisions to read directly the volume of gas. There is every reason to believe that this type of gauge will be used not only for measuring low velocities of fluid, but also for indicating the draft in chimneys and furnaces, since such readings are usually very small and the effect of the draft upon the supply of air to the furnace is proportional to the square root of the pressure difference as conveniently indicated by the square root differential gauge.

PART II.—VARIOUS TYPES OF PRESSURE GAUGES, THEIR APPLICATION IN THE GAS WORKS.

One of the most essential auxiliaries in a gas manufacturing plant is the pressure gauge which plays a very important part in the successful operation of the various units comprising the plant, and the plant on the whole.

In the steam generating plant, the gas generating units, the works auxiliaries and the distribution system, pressure gauges of both the indicating and recording type are installed in order to maintain uniform conditions, and hence economical operation of the plant.

Pressure gauges are of two kinds, indicating and recording for both high and low pressures. The function of the indicating gauge is to indicate the momentary pressure, and of the recording gauge, to produce a record of the pressures throughout the day, which enables one at a glance to note the variations in pressure. One can readily see the importance of the recording gauge, as for instance in the steam generating plant, where a large fluctuation in pressures means loss of economy in the operation of the plant. In the water gas plant, continuous records of the pressure under the grate bars of the generator at all times, of the blast pressure at the blower, of the oil pressure at the oil pumps and the steam pressure at the machine, are the means of insuring regularity of operation and the most efficient results from the machine. In the carbonizing plant, where it is necessary to carry a slight vacuum in the hydraulic main, in order to take the gas from the retorts as fast as it is made to prevent the gas from leaking through the retorts and burning up in the combustion chamber, and to prevent the hydrocarbons in the gas from breaking down and forming lampblack and carbon, a continuous record of the vacuum carried at the hydraulic main and at the exhauster is absolutely necessary for maximum efficiency of the plant, for both quality and yield of gas produced.

Too much importance cannot be given the records produced by the recording gauges as the means for maintaining uniform conditions, and economy of operation. Once the attendant recognizes this fact, the moral effect of the recording pressure gauges is conducive to good work on his part, and is a valuable help to him in maintaining a high standard.

Installation of Gauges.

Great care should be exercised in the installation of pressure gauges and manometers. (1) The pressure lines or connections should be of sufficient size to prevent constant plugging up, owing to deposits of tar, naphthalene or rust, as the case may be. (2) The lines should by all means be run whereever possible so that there will be a gradual slope from the gauge to the main, so that should there be any condensation formed, it may drain back to the line. If a trap should exist in the pressure line, the condensation would lodge in the trap and the pressures indicated and recorded would be in error to an amount equivalent to the static head of the condensate acting against the pressure. (3) Where it is impossible to install the gauges so that the pressure lines will have a gradual slope from the gauge to the main, the pressure pipes should be run overhead to avoid forming a loop in the line. In such cases the pressure lines should have a gradual slope back to the main from the point where the line drops down to the gauge. On the line dropping down to the gauge, a small drip box should be installed just before the line enters the gauge. This drip box will catch whatever condensation takes place in the line dropping down to the gauge, and if drained periodically, insures the accuracy of both the indicating and recording gauges.

Steam gauges, mounted on a board at a distance from the boiler, have the pressure lines run overhead dropping down to the gauges on the gauge board. The pressures shown will be in error to an amount equivalent to the head of water in the vertical line above the gauges. One way to insure correct indications of pressures is to determine the actual head of water above the gauge, and set the indicator on the indicating gauge, and the pen-arm of the recorder back an amount equivalent to this head of water.

Description of Gauges.

The U-tube Manometer.—For indicating the gas pressures around the works, and for low pressure gas distribution, the U-tube pressure gauge is generally made use of. A convenient form of this gauge is shown in Fig. 8. It consists of a glass tube bent into the form of a U with a scale between the legs graduated in inches and tenths. The liquid is water or oil for pressures up to two pounds, and mercury for higher pressures. Where water or oil is used a coloring matter is added to render the reading more visible. Pressure is admitted to one leg of the U-tube, depressing the liquid in that leg and elevating it an equal amount in the other leg. The difference of levels of the liquid in the two legs is the measure of the pressure applied in terms of the liquid employed. The scale is provided with slotted holes for the fastening screws so that a slight adjustment for change of zero level of the liquid may be allowed for.

Single Tube Type.—A more convenient form for indicating pressures in the above cases, is the single tube type of gauge shown in Fig. 9, which can be used for low pressure indications, and type shown in Fig. 10 for high pressure indications. In Fig. 9, a square box for water reservoir is placed at the bottom of the tube and directly in back of it. Water is poured into the box through the funnel at the top, attached to the vent cock, and by means of an opening in the casting supporting the tube on the front side of the box, rises in the tube. The level of the water can be adjusted to the zero mark by means of a drain cock on the bottom. The tube is set in stuffing boxes, which are made tightly by means of candle wick packing and held firm by means of a metal strip fastened to the water box on the bottom, and the stuffing box casting on the top. This metal strip also is made use of to support the scale. In the rear of the box, and cast as one piece with it, is a metal plate for bolting gauge to gauge board. For water, all parts can be made of brass. The pressure pipe enters at the bottom

"U" GAUGE

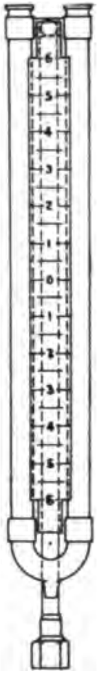


Fig 8

SINGLE TUBE PRESSURE GAUGE

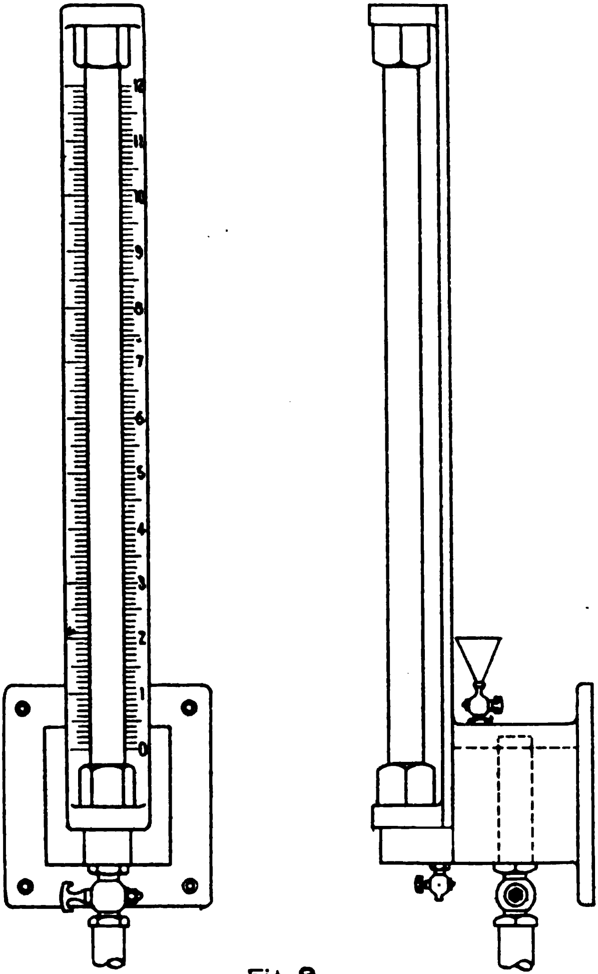


Fig 9

FRONT VIEW SIDE VIEW

SINGLE TUBE PRESSURE GAUGE

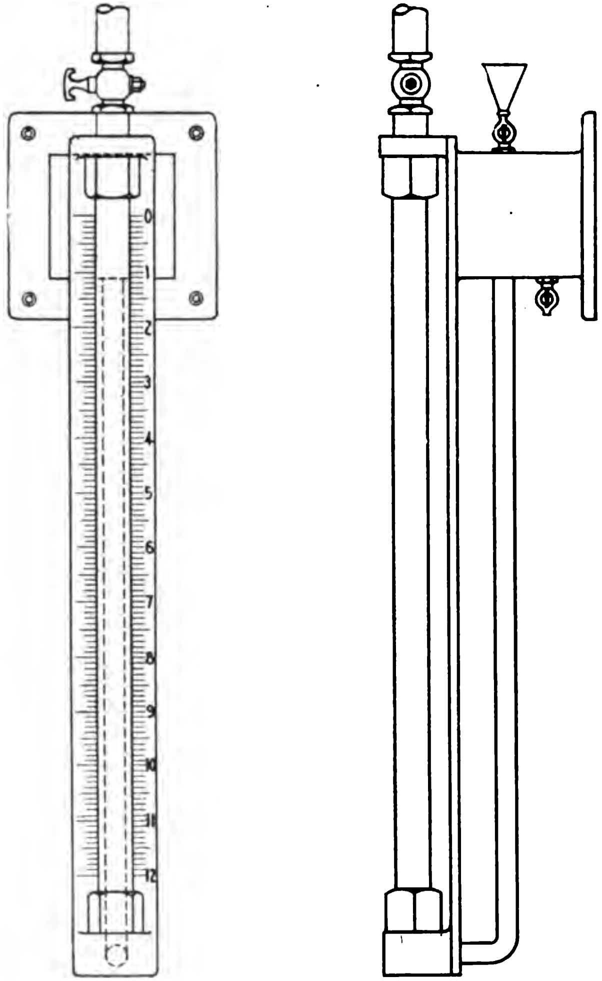


Fig 10

FRONT VIEW — SIDE VIEW

in the center of the box, and extends slightly above the water level. In this figure, the box measures 2½ inches square in cross section and 3 inches high, the glass tube is ⅝ inch diameter and the pressure pipe is ⅜ inch standard gas pipe.

When the gauge is put into use the vent cock on top of the box and the drain cock on the bottom of the box are closed. The cock on the gas pipe is then opened and the pressure applied to the top of the water forces it up the glass tube in proportion to the intensity of the pressure, the top of the tube being open to the atmosphere. The rise of the water above the zero is the intensity of the pressure applied.

The pressure applied to the surface of the water in the water reservoir, displaces an amount of water equivalent to the volume of water in the glass tube above the zero mark on the scale. Hence the water level in the water reservoir is lowered, and the zero point is also lowered by the same amount. But as the zero point on the scale is permanent, and cannot be adjusted for all varying pressures, the necessary correction for indications of pressure at all times must be made in the graduations on the scale. This can be easily done as follows:

Let A equal the area of the cross section of the water reservoir and B equal the area of the cross section of the glass tube, and let X equal the distance the water in the water reservoir is lowered for 1 inch rise in the glass tube. Since the volume of water displaced in the water reservoir is equal to the volume of water in the glass tube above the zero of the scale then for 1 inch rise in the tube $1 \times B = A \times X$, or $X = \frac{B}{A}$. Hence the divisions on the scale instead of being in exact inches, must be slightly less than inches or $(1 - X)$ inches for correct indications for all pressures.

However, if $\frac{B}{A}$ is very small due to large cross section of water reservoir no correction need be made.

The main advantage of the single tube manometer or gauge is that the readings of the scale are indicated directly without the manipulation necessary for computing the readings of the ordinary U-tube gauge scale.

In Fig. 10 is illustrated a single tube pressure gauge suitably adapted for indicating higher pressures as for high pressure gas distribution systems. As mercury is the liquid for indicating the pressures, the gauges should be made of iron, for mercury in contact with brass amalgamates and forms an alloy. Mercury being expensive, this gauge is so designed that it is impossible to lose it, should the pressure applied exceed the limits of the scale.

The construction of this gauge is similar to the type shown in Fig. 9 with the exception that the reservoir and zero of scale are at the top. The pressure is applied to the top of the glass tube and the scale is read downwards. Before the gauge is put into use, mercury is poured into the reservoir and rises in the glass tube through the pipe connection as shown in figure. The mercury is brought to the zero mark on the scale by means of the drain cock on the bottom of the reservoir. The vent cock on the top of the reservoir must be open at all times, and the drain cock must be closed.

When pressure is applied to the tube, the level of the mercury in the tube is lowered and the level of the mercury in the reservoir rises, and hence the zero mark rises. But as the zero mark on the scale is permanent, the correction in the graduation of the scale must be made the same way as for the gauge shown in Fig. 9.

In the event of excessive pressure the mercury is blown into the reservoir, and remains there until the excessive pressure is relieved.

Differential Pressure Gauges.—Some of the gas works apparatus are designed to throw a predetermined differential pressure. To maintain economical operation of such apparatus, a differential pressure gauge both of the indicating type, the U-gauge as shown in Fig 11, or the single tube type as shown in Fig. 12 may be used. In Fig. 11 the glass tube fits into stuffing boxes; the liquid is brought to the zero of the scale, and the pressures are applied to the top of the liquid in each tube. The difference in elevation of the surface of the liquid in the tubes, being the indicated differential pressure.

In the single tube type shown in Fig. 12, the construction of the gauge is the same as the type shown in Fig. 9. The correction of the graduations of the scale for correct indications of the pressures applied, is the same in this type as in types shown in Fig. 9 and Fig. 10. In the single tube differential gauge, the greater pressure is applied on the surface of the liquid in the reservoir, and the lesser pressure is applied to the

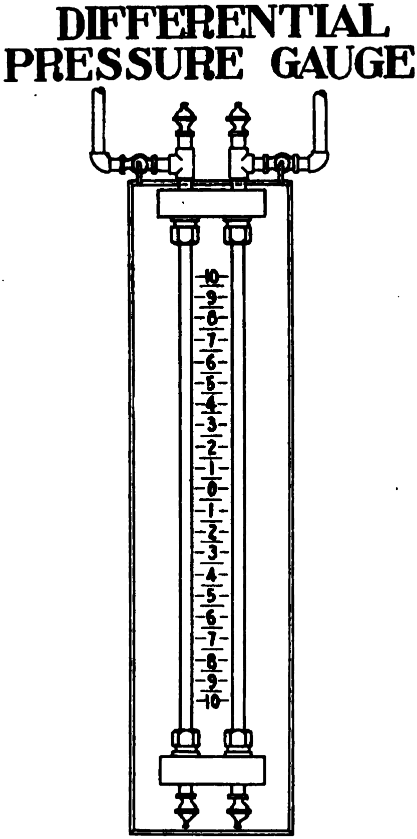


Fig 11

DIFFERENTIAL SINGLE TUBE PRESSURE GAUGE

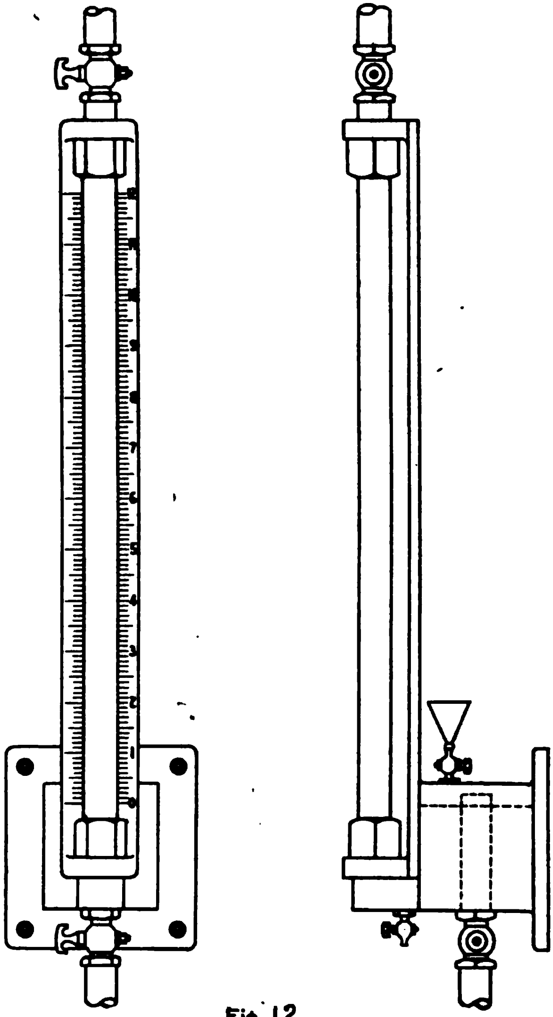


Fig 12

FRONT VIEW

SIDE VIEW

surface of the liquid in the glass tube. The rise of the liquid in the glass tube above the zero of the scale is the indicated differential pressure.

In Fig. 13 is shown a manometer for mercury, which may be used for pressure, vacuum, or differentially. The special feature of this device is that if excessive pressure is applied, the mercury is forced into the upper casting until the pressure is relieved when the mercury returns, preventing loss of mercury and damage to brass fittings. The gauge has an iron base in which is a large mercury well. The upper casting has a cavity large enough to hold all the mercury should it be forced up, and is connected to the lower casting by two steel rods one of which is hollow for transmitting the lower pressure. The glass tube is between these rods with a scale just behind it.

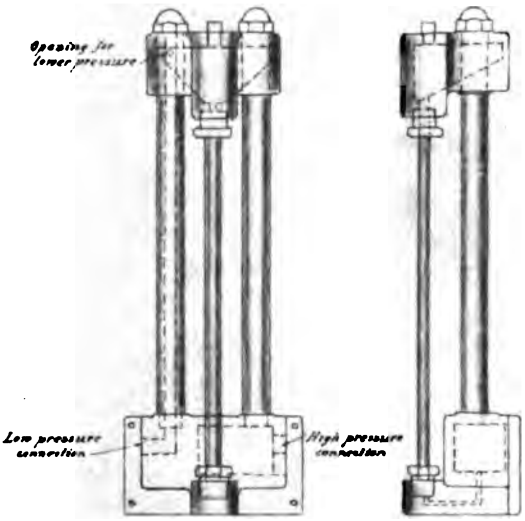


Fig. 13
Differential Single Tube Pressure Gauge

The pressure connections are made in the bottom casting, this obviating twisting of the frame which would cause breakage of glass.

High Pressure Gauges.—In the high pressure indicating gauge, for pressures ranging from 5 to 200 pounds, or more, use is made of the Bourdon spring, which is of bronze composition, circular shaped, and has an elliptical bore through its center. When pressure is exerted it tends to straighten the spring. This motion is transmitted, by means of a lever attached to the free end of the spring to a quadrant of a circle, the teeth of which mesh with a small pinion on the shaft carrying the indicator arm. This arm moves over a circular dial graduated to read the intensity of the pressure direct in pounds per square inch.

Long Distance Gauges.—Devices have been developed for transmitting and indicating pressures existing at distant points. An ingenious example of this kind is the unison telemetric gauge which transmits electrically and indicates on a gauge dial pressures existing at any distance from the place where the dial is located. This gauge can be successfully applied for proper distribution of gas in the gas mains.

Recording Gauges.—In the recording high pressure gauges, the helical hollow tube is employed. In some instruments the pen-arm is attached to the free end of the helical pressure tube. When pressure is applied to the helical tube, it tends to uncoil, thereby transmitting its motion to the pen-arm which moves over a predetermined arc on a chart which is graduated to record pounds per square inch within the range of the spring. These charts are graduated in time units, and placed on a chart holder which in turn is attached to a clock mechanism causing it to revolve. The pen-arm on the free end contains a V-shaped ink holder, or pen, which terminates to a point, and slopes slightly towards the chart. The pen of the pen-arm barely touches the chart, and as the chart revolves a continuous record of the pressure is produced.

In other instruments the pen-arm is attached directly to a shaft, which passes through the center of the helix, and is supported at both ends. This shaft is connected to the free end of the tube by a special connection, which is flexible only in the direction of the radial expansion of the tube. As the pressure is applied to the helical tube, it tends to uncoil and transmits its motion to the shaft, which in turn transmits it to the pen-arm, causing it to move over a predetermined arc, a distance proportional to the pressure applied.

In the low pressure recording gauge a series of diaphragms are joined at the center, their interior being interconnected. A flexible strip is fastened to one side of the series of diaphragms, and the pen-arm is fastened to the top of this strip. The action of the pressure is to distend the diaphragms, but being restrained from elongating by the binding strip, the series bows out sideways. This lateral motion is transmitted to the pen-arm which moves over a chart actuated by clock work.

Differential Recording Gauge.—The differential recording gauges are designed to measure and record difference of pressure, and may be used for this purpose when the static pressure involved is either high or low. Of the many applications for recording differential pressure gauges, some of the most important uses are in connection with Pitot tubes, Venturi meters, orifices and combinations of orifices and Pitot tubes for recording rate of flow of air, gas, steam and water and also for recording the water level in boilers. Of the many uses a differential recording pressure gauge may be put to, one can readily see what a valuable asset it is for the economical operation of a plant; as it will record the actual difference of pressures, or the amount of air, gas and liquids corresponding to a certain differential pressure. In the boiler plant, for instance, in recording the water level, it gives an absolute check on the fireman's attention to the boilers, such as high and low water and blow down boilers, which makes it an absolute safeguard against accidents and damage.

The principal of the recording differential pressure gauge is the same for both high and low static pressures, with the exception that where low pressures are involved, the diaphragm tube is made use of, while where high static pressures are involved, the helical tube is made use of.

In Fig. 14 and 15, are shown sections of the differential tubes for low and high static pressures respectively. The tubes are shown enclosed in pressure tight casings *A*. In both cases one of the pressures is applied to the inside of the tube, and the other to the outside of the tube. The movement of the pressure tube being in proportion to the differences of the two pressures applied, is transmitted to the recording pen-arm *B* on the outside of the pressure casing, by means of the shaft *C* through the tubular sleeve *D*. The movement of the shaft *C* in the tubular sleeve *D* is made frictionless by means of an oil film between them, and hence the differential pressure may be recorded with a great degree of accuracy regardless of its magnitude. Another function of the oil film

SECTION OF DIFFERENTIAL TUBE FOR LOW PRESSURE RECORDING GAUGE

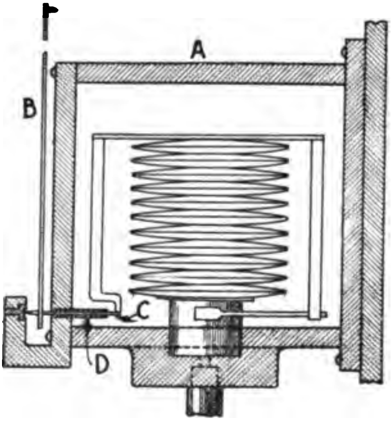


Fig 14

between the shaft *C* and the tubular sleeve *D* is to make it pressure tight.

Under practical operating conditions, it is usually found that the differential pressures to be recorded are very small in comparison to the static pressures involved. It is obviously of great importance to have these recorders connected up so that the moving element of the recorder will be subjected to static pressures on both sides simultaneously, and protected in such a way that the recorder can never be subjected to a differential pressure higher than the range for which it was originally designed. Should the range be exceeded as for instance by applying only one of the static pressures to the tube, it may result in the destruction of the tube. Precautions must be taken in the installation of the gauges and operation of same so that no such conditions may arise. In Fig. 16 is shown one way of installing differential recording gauges as a safe-guard against accidents.

SECTION OF DIFFERENTIAL TUBE FOR HIGH PRESSURE RECORDING GAUGE

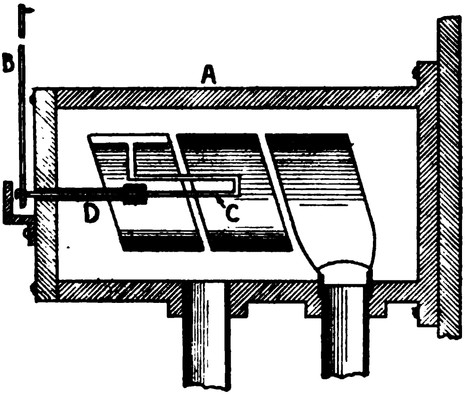


Fig 15

In this figure is shown a cross connection with a valve *A* between the pressure pipes. In putting gauge into operation valves *A, B* and *C* should be closed. Then valve *A* should be opened first. Now if valve *B* is opened, the same static head will be applied to both the inside and outside of the tube. Valve *C* may then be opened and valve *A* closed. The instrument is then ready to record the differential pressure.

SKETCH SHOWING SAFETY DEVICE FOR CONNECTING RECORDING DIFFERENTIAL PRESSURE GAUGE

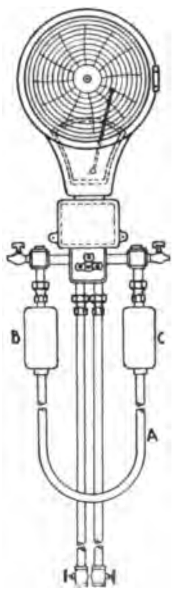


Fig 17

SKETCH SHOWING PRESSURE PIPE CONNECTIONS FOR RECORDING DIFFERENTIAL PRESSURE GAUGE

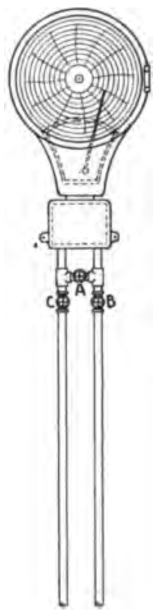


Fig 16

Another safety device is shown in Fig. 17 which consists of a U-shape tube *A* partly filled with a suitable liquid such as mercury or water, this tube having enlargements *B* and *C*, either one having sufficient volume to accomodate the quantity of liquid contained in the U-tube. The length of the U-tube varies with the range of the gauge so that the greatest possible head of the liquid contained in the U-tube corresponds with the total range of the differential pressure that the gauge is designed to record.

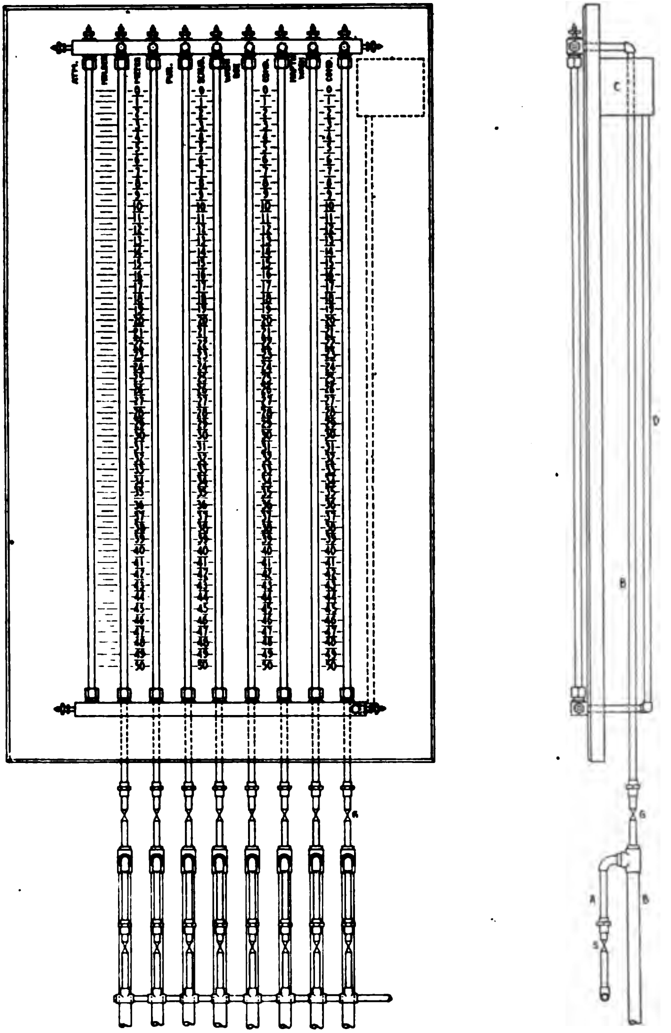
Should the full static pressure by accident be admitted to either side of the differential gauge, the liquid contained in the safety U-tube would instantly be forced up into one of the enlargements, thus allowing the static pressure to be applied simultaneously to both inside and outside of the pressure tube and protecting it from being destroyed. This device is used in conjunction with the three valve system shown in Fig. 16. It is merely a double safe-guard, and makes the instrument fool-proof.

Pressure Gauge Board.

It is generally the case, when pressure gauges are installed promiscuously and in obscure places that they become neglected by the engineer, owing more or less to the fact that he has various other duties to fulfil, and become detracted from his mind. To avoid this difficulty, all pressure gauges should be assembled on one gauge board in the engine room, so that they are constantly before the engineer, and that he or anyone else interested in the operation of the plant, as for instance the superintendent or assistant superintendent, may see at a glance, the conditions of his mains and various pieces of apparatus. It will also aid him in finding the exact location of any trouble, and give him sufficient warning to remedy same before more serious troubles may arise.

In Fig. 18 is shown one centralized pressure gauge board, suitably adapted for such use. The board itself in this particular case is made of oak, but can be made of slate or cast iron. The top and bottom gas manifolds, stuffing boxes and trimmings are made of brass and nickel plated. The scales are made of brass, the back ground being in blue enamel and the figures, division marks and names of apparatus being of white enamel.

PRESSURE GAUGE BOARD



FRONT VIEW SIDE VIEW

Fig 18

The gauges on the board consist of a series of tubes set in stuffing boxes, attached to manifolds, and made tight by the aid of candle wick packing. The top manifolds has for each tube a hole drilled and tapped from the rear, and bottom to its center. The rear hole is for the gas pressure pipe connection, and the bottom hole is for the stuffing box for tube insertion. The bottom manifold has for each tube a hole drilled and tapped on top for the attachment of the stuffing box. It also has a hole drilled through its center throughout its entire length, such that when filled with water from water reservoir *C* and pipe *D* which is connected to it at one end, the water will rise in all the tubes simultaneously to the zero mark at the top of the scale, and *vice versa,* as pressure is applied at the top of the various tubes through pipes *B,* the water is displaced in the various tubes, owing to the intensities of the respective pressures applied to them, will be forced back through pipe *D* to reservoir *C*.

This particular gauge board was designed to indicate the various pressures in a coal gas plant, of the flow of gas from the exhauster to the holder, the tube on the extreme left only being open to the atmosphere. It is merely a series of single pressure tubes combined, that they not only indicate the intensity of the pressures at the inlet and outlet of the various pieces of apparatus, but also the differential pressures over the same as well. By a continual study of the pressures on the gauge board, one can readily see when to apprehend trouble, and take the necessary steps to remedy same before more serious results happen. It is also a means of finding the exact location of trouble, and there is no time lost in inserting a gauge here and there to run down the exact location.

From the point of economy, the assembled pressure gauge board is a valuable help to the operator of the plant. Abnormally high pressures mean more duty for the exhauster to perform, and hence greater steam consumption, and poorer economy. From this standpoint alone, the pressure gauge board is indispensable, as it is an insentive for the engineer to maintain the most economical operating conditions.

To indicate the pressures correctly on the gauge board, the precautions outlined at the beginning of this part, for the proper installation of gauges, should be followed very carefully. In coal gas plants where high heats are carried for high gas productions per pound of coal, one source of trouble the gas man has to contend with is naphthalene. This naphthalene is a source of trouble not only in the gas mains and the various pieces of apparatus, but also and more frequent in the gas pressure pipes to the pressure gauge board. The naphthalene deposits in the pressure pipes, and eventually plugs them off and impairs the correct pressure indications, and it sometimes becomes necessary to remove the pipe in order to remove the naphthalene stoppage. In Fig. 18 means have been provided to eliminate this source of trouble to a great extent. Pipe *B* as in side view, is a ¾-inch gas line leading from the gas main to the pressure gauge board and reduces to a ⅜-inch pipe at the board. Pipe *A* is a ⅜-inch steam line connected to pipe *B*. By closing valve *G* and opening valve *S*, steam is allowed to blow through pressure pipe *B* back to the main, thus cleaning pipe of all tar and naphthalene deposits. In Fig. 10 each pressure pipe is shown equipped with a steam connection, so that any one can be blown independently. By periodically blowing the various pressure pipes, they can be kept open to indicate the correct pressures at all times. To summarize the foregoing, for correct indications on the pressure gauge board at all times, provisions must be made to properly drain and clean the gas pressure pipes to the gauge board.

The type of pressure gauge board shown in Fig. 10 is suitable also for indicating the pressures of water gas in its flow from the water gas exhauster, through the various pieces of apparatus to the holder, and serves the same purpose as pointed out in the foregoing. It may be used also in connection with a water gas machine to indicate the differential pressures over the generator, carbureter and superheater, as a means of indicating the condition of the fire and the condition of the checker brick in the carbureter and superheater during the blasting period. In water gas practice, to get the most efficient results out of the machines, one must have uniform conditions. The amount of air delivered to the generator per minute of blow should be the maximum amount possible, and uniform throughout the day. To obtain this result the condition of the clinker and fire in the generator should be such to offer the least possible resistance. The checker brick in both carbureter and superheater should be free of carbon so as to offer the least possible resistance to the flow of blast gases. With the aid of the pressure gauge board, these conditions can be readily ascertained and also the effect of such conditions upon the efficiency of the machine.

PART III. VARIOUS TYPES OF PYROMETERS THEIR APPLICATION IN THE GAS WORKS.

In the operation of a gas producing plant where modern practice is in vogue and where high efficiencies are to be obtained, the ability to measure accurately the temperature of hot gases, retorts and settings, furnaces, fixing chambers of water gas sets, etc., is an absolute necessity. It is also of vital interest to measure accurately, and record temperatures of the flue gases in the boiler plant of the feed water, the gas condenser, ammonia concentrator, and also the temperature of the gas measured by the station meter.

The importance of recording the station meter temperature is realized from the fact that the correction factor of a saturated gas is about 1 per cent. of the volume for each 3 degrees change in temperature. In gas works where the gas temperature at the meter varies from 10 to 15 degrees, it is hardly advisable to have the adjustment of the volume left to occasional readings of an indicating instrument.

The measurement of temperatures up to 1,000° F., presents no great difficulty, as, for many years mercurial thermometers, whose principle of operation is too well known to require description, have been used with perfect success.

The measurement of temperatures above 1,000° F., however, is a much more difficult matter, and mercurial thermometers are of little or no use for the work. Many schemes for the measurement of such temperatures have been envolved in which the relation of the expansion of some solid or liquid to the change of temperature has formed the basis for the measurement. Nearly all such devices which depend upon this relation fail to give dependable results because at high temperatures, this relation does not remain constant. There is apt to be a permanent expansion of the material used, which interferes with perfect accuracy, or, which is still more important, with ability of the instrument to repeat its readings a number of times when the object under observation is at the same temperature each time.

Instruments which have been developed for measuring higher temperatures are called pyrometers. Of those in common use for industrial purposes, there are four distinct classes of entirely different principles, which are most worthy of consideration.

1. Thermo-electric pyrometers, whose readings are based upon the principle that the force of an electric current generated by the effect of heat upon the junction of two dissimilar metals is proportional to the intensity of the heat. In this type the thermo-couple is heated by direct contact with the hot body whose temperature is being measured and attains the same temperature as this body. This class is used very extensively in the gas works and the principle is dwelt upon in greater detail in this report.

2. Resistance pyrometers, whose operation depends on the effect of heat upon the resistance of a metal conductor to the passage of an electric current.

3. Pyrometers of the radiation type, whose registration depends upon the force of current generated in a very sensitive thermo-couple by focusing upon it the radiation from the hot body by means of a lens and mirror, the force of the current being proportional to the intensity of the heat rays and the intensity of the heat rays being proportional to the temperature of the body, according to the law of radiation. In this type of

pyrometer the couple, of course, does not attain the temperature of the hot body.

4. Pyrometers whose working principle is the photometric comparison of the intensity of light radiations from the hot body with those from a standard source such as the filament of a small electric lamp, the intensity of the radiations from the standard being representative of a known heat intensity. These are known as optical pyrometers.

The Thermo-Electric Pyrometer.

The thermo-electric pyrometer consists of a thermocouple, or fire end, which is connected by leads of convenient length to a galvanometer or sensitive milli-voltmeter, the scale of which may be calibrated to read directly in degrees temperature. The fire end, which is placed in the heat, consists of two wires or bars of dissimilar metals, or alloys, joined at one end, and insulated from each other for the remainder of their length. The junction forms a thermo-electric couple, and when heated, generates an electro motive force, the intensity of which is dependent upon the kind of metals, or alloys used, and the difference in temperature between the junction or hot end and the opposite or cold end of the couple.

Kinds of Thermo-Couples.

The metals suitable for use as thermo-couples, are copper, iron, nickel and platinum, and the alloys of copper, nickel and platinum. In all couples the e. m. f., developed by the junction should increase uniformly as the temperature rises, and the melting point of either component should be well above the highest temperature to be measured, so that the thermo-electric value of the couple is not altered by prolonged heating. As the melting points of the components of the couples are all different, different couples are generally employed to measure different ranges of temperature. Below is a table showing the upper limits to which given metal couples may be used.

TEMPERATURE LIMIT OF THERMO-COUPLES USED IN PYROMETERS.

Couples	Upper limit to which couple may be used. Deg. C.	Deg. F.
Platinum and Rhodio-platinum (10 per cent. Rh.)	1,400	2,550
Two platinum alloys of different composition	1,600	2,900
Platinum and iridio-platinum (10 per cent. Ir)	1,100	2,000
Nickel and constantan	1,000	1,850
Nickel and iron	1,000	1,850
Iron and constantan	1,000	1,850
Nickel and copper	900	1,650
Copper and constantan	800	1,475
Silver and constantan	800	1,475
Two nickel and chrome alloys of different compositions	1,350	2,460

The first thermo-couples used were the platinum, using platinum wire for the negative element and an alloy of platinum and 10 per cent. of iridium for the positive. This couple was first used by LeChatelier and in connection with the high resistance galvanometer, it is known as the LeChatelier pyrometer. This couple up to 1,000° C. was found to be very reliable, but beyond 1,100° C. the iridium—in the iridium-platinum alloys was found to vaporize in tangible quantities, causing a discrepancy in the indications of the temperatures. On account of this defect, this couple soon gave way to the platinum,—platinum rhodium (10 per cent. rhodium) couple, which is more constant in its behavior at high temperatures under continuous use, although it gives a somewhat lower e. m. f. than the platinum-platinum iridium couple. This couple may be used for short intervals for temperatures as high as 1,600° C. (2,912° F.). Under long exposure, even when protected in the best porcelain tubes, the evaporation of the platinum at the hot junction, and its absorption, by the platinum-rhodium gradually reduces the e. m. f. of the thermo-couple. Moreover, the porcelain or quartz tubes do not prevent the access of various contaminating gases to the platinum thermocouple, and this permits in time such alterations as to necessitate frequent recalibration.

The electro motive force developed by the platinum iridium-platinum and the platinum-rhodium platinum couples, is extremely low, also the high cost of platinum makes it necessary to use very small wires which introduce high resistance into the circuit. As a result the current produced by the couple is very low, and its accurate measurement demands an exceedingly delicate and sensitive galvanometer, which must needs be of the high resistance type.

Up to 10 or 12 years ago it was practically impossible to obtain thermo-couples adapted for this kind of work other than those made of precious metals,—platinum and rhodium being the usual metals employed. The daily use of such couples about gas works, furnaces, retorts, generators, etc., where there was strong likelihood of their being permanently damaged, was out of the question on account of their cost. They were in use in some works but generally only in the laboratory or upon some very important piece of research or experimental work, and in the hands of some one expert in handling delicate instruments. Not until the advent of the base metal couple pyrometers, of which there are several types, did this instrument come into daily and hourly use and become a regular auxiliary of gas works operation;—at least this is true so far as the United States is concerned.

Base metal couples of nickel, copper, iron in combination, or with the alloy constantan, which consists of nickel and copper in varying proportions, give very concordant results in the measurement of different temperatures. For temperatures below 1,000° C., or 1,832° F., the base metal couples are preferred to the platinum thermo-couples. In the first place they are much cheaper, and in the second place the electro motive force developed by base metal couples is much higher for given temperatures than that developed by the platinum thermo-couples.

The following table shows the electro motive force developed by various couples for a rise of 100° C. at the middle of the working range of the couple.

Couple	Millo-volts per 100° C.
Platinum-rhodio platinum (10 per cent. Rh)	1.1
Platinum-iridio platinum (10 per cent. Ir)	1.2
Nickel-constantan	2.3
Copper-constantan	5.8
Nickel-copper	6.1
Iron-constantan	6.7
Iron-nickel	7.5

It will be noted from above table that the cheap metal thermo-couples give much higher e. m. f. values than the platinum series, and hence can be used with less sensitive, and cheaper galvanometers of the pivoted and low resistance type. Also on account of the cheapness of the metals, the components of the thermo-couples are made generally large in cross section so as to offer the least resistance to the current produced at the different temperatures. The iron constantan thermo-couple is most generally used for measuring temperatures below 1,000° C. (1,832° F.). It gives a very high e. m. f. being about six times that of platinum and is very consistant even after a long use. It is this thermo-couple, which is generally used to measure the temperature of the checker bricks in the water gas generator.

Proper Insulation of Thermo-Couples.

In all thermo-couples the dissimilar metals or wires must be insulated throughout their length except at the tip where they are welded together. In the platinum thermo-couples the wires are insulated by means of fire clay tubes and the couple is then placed into an iron sheath. This iron sheath is again placed into an iron pipe which extends to the heat zone as a protection to the couple from the effects of contaminating gases. In the base metal thermo-couples the dissimilar metals or alloys are insulated by means of asbestos cord wrapped around them. They are also protected in a similar manner by an iron sheath, and an iron pipe. This iron pipe should be inspected periodically, as long exposure in the heat causes oxidation of the iron, which if not renewed in time will eventually destroy the thermo-couple. By black leading the iron pipe sheath once per week, it will greatly prolong its life; but it should immediately be replaced when it becomes dangerously thin.

A satisfactory casing for fire ends in water gas machines has been found in extra heavy pipe, usually ¾ inch or 1 inch size, and made up with a 1¼ inch bushing. This construction permits easy renewal when recheckering, or when casing has become burned out. It is advisable to use as small amount of metal as possible in plugging the ends of casing pipes, in order to minimize the lag.

Another kind of base metal fire bar construction is known as the pencil type, in which one of the elements of the couple is a tube, the other element being a wire carried through it to the junction where the elements are welded together as in all coupled. The wire is insulated from the tube through its length by being tightly packed with asbestos material. With this construction the possibility of short circuit is permanently eliminated. The couple itself may be bent into any given position without injury if a 2 inch radius of curvature at the bend is maintained. Further it is so designed that its resistance regardless of length is the same, hence all couples are practically interchangeable.

Wire Connections.

Lead wires from the fire end to the galvanometer may be of any length required. It is advisable especially where low resistance instruments are used, to calibrate the leads to a standard resistance in order that units may be interchangeable. A slow burning or asbestos insulation should be used where the wires are exposed to heat. The use of rubber insulation should be avoided near gas machines. For permanent circuits it is advisable to place the wire leads in pipe conducts whereever possible.

For measuring temperatures in a water gas set it is customary to have an indicating and a recording instrument connected to the same thermo-couple. The purpose of the indicator being to indicate the temperature momentarily, and the purpose of the recorder being to give a continuous record of the temperatures in the machine throughout the entire operation. The general method of doing this is to run a set of leads from the fire end to the terminals of the indicating instrument, and from these terminals run another set of leads to the terminals of the recording instrument. It is also customary to connect up the recording instrument with a double throw switch so that it may be used to record alternately the temperatures of two fire ends.

Types of Thermo-Electric Pyrometers.

Thermo-electric pyrometers are divided according to the resistance of the circuits into high resistance and low resistance pyrometers. The resistance of the circuit is made up of three distinct parts. First is the internal resistance of the galvanometer. Second is the resistance of the wires or bars forming the couple, and third is the resistance of the leads connecting the couple to the galvanometer.

For the platinum thermo-couple, which is of high resistance and low electro motive force, the high resistance galvanometer is a matter of necessity. For the base metal couple which has a low resistance and develops a high electro motive force, the high resistance galvanometer is merely a matter of advantage and accuracy.

There are two things to be done in a pyrometer and they are done by two parts of the instrument. First there is the thermo-couple in which is generated the current. It is more correct to say that the voltage or electrical pressure is made in the thermo-couple. The higher the temperature, the higher the voltage. The amount of actual current that flows depends not only on the voltage or pressure, but on the resistance of the whole circuit including the thermo-couple itself, the leads and the instrument. The first requisite is that the thermo-couple shall always develop the same voltage for the same temperature and that all of the thermo-couples shall be alike in this respect and develop the same voltage for the same temperature. If they do not do so they are not interchangeable.

The galvanometer is used to measure the voltage that has been developed, and the high resistance of the instrument is simply a factor in the degree of accuracy with which the instrument does really measure that voltage. Inasmuch as the voltage has to be measured in the instrument, which itself contains coils of wire through which the current must pass, and as the current must also pass through the connecting wires and through switches and through the thermo-couple itself, the instrument, while its purpose is to measure voltage, does not truly measure voltage, but measures the amount of current that flows.

If the electrical resistance of the whole circuit would remain absolutely constant under all conditions of use, then, and then only, could the instrument be considered as truly measuring the voltage which is what we would like to have it measure, because it is the voltage that changes with the temperature.

The little motor or moving coil in the instrument, which may be hung on a fiber or set upon one pivot or upon two pivots, turns in opposition to a spring which is set to hold it at zero. It is the amount of current, or in other words, the number of amperes flowing through the motor or moving coil, which determines the reading of the instrument. It would be very nice if the amount of current flowing would increase in exactly the same proportion that the voltage developed in the thermo-couple increases, and so it would if we could make the resistance of the whole circuit remain constant. The higher the resistance of the circuit, the less current will flow for any given voltage. The lower the voltage, the less current will flow for any given resistance; also a change in resistance changes the amount of the current and a change in the voltage changes the amount of the current, yet it is simply the amount of the current that determines the reading of the instrument. When the pointer moves on the instrument it is not certain whether it moves because the voltage has changed or whether it moves because the resistance has changed. Inasmuch as we want it to move only when the voltage changes, the problem is, to hold the resistance constant so that it will not change and so that when the pointer moves, it shall always mean that the voltage has changed, and which in turn means that the temperature has changed.

Sometimes bad contact at a switch will change the resistance; heating the thermo-couple for more or less of its length, changes the resistance of the thremo-couple. It is only the junction which, undergoing changes of heat, results in changes of voltage, but heating any other portion of the couple, changes the resistance to the passage of the current because almost all metals offer a greater resistance to passage of a current when heat then when cold.

The copper connecting wires running from the thermo-couple to the indicator change considerably in their resistance under atmospheric temperature changes. The moving coil or motor of the instrument is wound with copper wire, and this copper, as well as the copper in the connecting wires, will change in resistance with changes of temperature and between morning and night of the same day, and also from season to season, the temperature of the instrument is bound to change and so the resistance of the wire winding of the motor coil are bound to change and all these changes of resistance change the amount of current flowing.

It is impossible to prevent having these changes of resistance in the circuit. If we cannot eliminate them, how then can we at least eliminate their effect on the readings?

If a resistance of 1 ohm is added to or subtracted from a resistance of 200 ohms, the difference is only one-half of 1 per cent. If a resistance of 1 ohm is added to or subtracted from resistance of 10 ohms, the difference is 10 per cent. For that reason, when the internal resistance of the galvanometer is increased considerably, a little change in the resistance of the circuit is negligible and not noticed.

On the other hand, the high resistance of the galvanometer necessarily reduces the amount of current flowing through the circuit for the given electro motive force developed by the couple. The exceedingly small current is not sufficient to overcome the friction of the jewel bearings in the pivoted galvanometer, and originally the suspension coil galvanometer, which is practically frictionless, was the only type that could be operated with high resistance by the available electro motive force of the couple.

The introduction of the high resistance pivot type galvanometer marked a real progress in pyrometer work. In the suspension type where the moving coil hangs on a fiber, this fiber is likely to snap, and furthermore, unless the instrument is set perfectly level, the coil does not hang in the proper position, and as the coil and fiber constitute practically a pendulum, the vibrations which are present in almost every plant, set the coil swinging. As the pointer is attached to the coil, the pointer also swings in the presence of vibration. The high resistance pivoted galvanometers unites the accuracy of the high resistance with the convenience and practicability of the pivoted instrument.

The galvanometers employed in the high resistance type, contain internal resistance of 200 ohms or more. In this class comes the first commercially important pyrometer of the type known by the name of its developer—Le Chatalier. Wires of platinum and platinum 10 per cent. rhodium form the couple, and the galvanometer is of the suspension coil type. This instrument has been standardized by various government bureaus, and because of the uniformity of the electro motive force generated by the platinum rhodium couple, is frequently used as a test or calibrating instrument. The high cost of the couples, and the delicacy of the galvanometer, however, have prevented its wide adaption for generator house work.

The high resistance instruments of the pivoted type are also necessarily delicate and require care in handling, and protection from dust and excessive vibration. Where proper provision has been made for them, they give very satisfactory service when installed on generator house gauge boards. Instruments of the suspension type are adapted more to laboratory then to generator house work.

In the low resistance type, the circuit is designed with from

5 to 15 ohms resistance. The current available is, therefore, very much greater than that in the high resistance type, and as the torque exerted in a galvanometer depends upon the current, a more rugged construction may be employed in the instruments which is an advantage where they are exposed to heat, dust and vibration. It is necessary, however, to calibrate the connections to a standard resistance and to guard against any variations from this in the operation of the instrument. Slight changes in the resistance of the couple, leads or contacts may amount to a considerable percentage of the total resistance in the circuit and introduces a corresponding error in readings. The low resistance instrument can not be used with any degree of accuracy for platinum couples in which the electro-motive force is very small.

Recording Pyrometers.

Recording instruments generally make an intermittent record in ink on various prepared papers in roll or circular form. They are made in various designs, each maker having developed a type according to his own ideas. The main objective in the design of the recorder is to prevent friction between the recording arm and chart, on account of the small current available for the operation of the instrument.

In the thread type movement a boom which terminates in a V-shaped piece of ivory is attached to the galvanometer indicating arm. By means of a cam rotated by a clock mechanism, a bar is made to descent at regular intervals pressing the boom end onto an inked thread and causing the thread to touch the chart which rotates on its axis once in 24 hours. The rotation of the cam alternately raises and depresses the boom, leaving it free for a sufficient time to assume its proper position for the corresponding temperature. The thread is kept moist by continually passing through an ink well over pulleys worked by the clock mechanism. A continuous record of small dots is obtained.

In the ribbon type, the boom is furnished with a pointed stylus, which is depressed by the descending bar on the record paper, beneath which is placed an inked ribbon. A small dot is thus marked on the under side of the paper, and is visible from above, the paper used being transparent.

In another type of recorder a smoked chart is caused to vibrate by the internal clock mechanism and brought into contact with the top of the indicating arm periodically, thus removing a small particle of lampblack from the smoked surface. The series of marks made by the periodic contact of the recording arm when the lamp black is removed, forms a continuous curve. The charts are caused to revolve by the clock mechanism once in 24 hours. The charts when removed, are placed in a bath consisting of alcohol and a small percentage of shellac which sets the lampblack, rendering the record permanent.

Still another type is the ink pad type, in which an inking pad is located in front of the chart over the arc traversed by the end of the recorder arm. A tiny capillary gold tube, open at both ends, is carried at the end of the recorder arm. When the chart is periodically vibrated, it is pressed against one end of the tube, and at the other end is pressed against the ink pad. A dot of ink is left on the chart and a further supply is simultaneously taken up by the tube from the pad. Between the vibrations the pen is free to move without friction. The periodic vibration results in a continuous record, the series of dots forming a curve corresponding to the change in temperatures.

In some instruments multiple records are obtained on one chart by automatically switching the connections of several fire ends to one recorder. The different records are distinguished from one another by the employment of a different length of ink mark.

Calibration of Thermo-Electric Pyrometers.

The calibration of the thermo-electric pyrometer consists in the determination of the temperatures corresponding to the e. m. f. developed by the thermo-couple of the pyrometer. The relation between temperature and e. m. f. for any couple is given by Holman's equation

$$\log E = A \log t + B;$$

where E is the electro motive force in microvolts, t is temperature difference between the hot and cold end in degrees centigrade; A and B are constants for any given kind of thermo couple.

The calibration of a given pyrometer can be accomplished by the use of this equation for which it is necessary to measure the e. m. f. developed by the couple for only two known temperatures, as far apart as possible in the working range of the pyrometer, in order to determine the values of the constants A and B, for the given couple. Thus knowing the constants A and B, the temperatures corresponding to the millivolt deflections of the scale of the instrument may be calculated for a number of points, and the scale divided to read the temperature difference directly.

Another method of calibrating the pyrometer is to subject the thermo-couple to temperatures of boiling points or melting points of various substances, and to note the corresponding deflection of the indicator over a scale. A number of materials of known boiling points may be taken for this purpose. The following table shows temperatures corresponding to the boiling points and melting points of materials usually employed for this purpose.

	Deg. C.	Deg. F.
Water of boiling point	100	212
Tin at melting point	232	449
Zinc at melting point	419	786
Antimony at melting point	631	1,167
Common salt at melting point	800	1,472
Copper at melting point (covered with graphite)	1,084	1,983

Having noted the deflections of the scale for the known temperatures, the whole scale can be divided to read temperatures directly. Also by noting the millivolt deflections for the known temperatures a calibration curve, showing the relation between millivolts and temperature, may be drawn from which a temperature scale for the pyrometer may be made.

Sometimes the calibration of the pyrometer is done by comparison with a standard instrument. In such cases the fire ends of both pyrometers are subjected to the same temperatures, and the temperature readings of the standard pyrometer are marked on the scale of the one to be calibrated.

In the calibration of pyrometers, the resistance of the leads is taken into consideration, that is the instruments are calibrated for a definite resistance in the whole circuit including the resistance of the leads. Although most makers use No. 12 Brown and Sharp gauge copper wire leads, the resistance of which is very small, a change in the length of the leads will cause an error in the temperature indication depending upon the type of the millivolt meter used. This error, as illustrated above, will be very pronounced in pyrometers where a low resistance galvanometer is used.

Cold End Compensation.

The electro motive force generated by a thermo-couple varies with the temperature difference between the hot and cold ends. For this reason a correction to compensate for changes in the cold end temperature from the standard at which the instrument was calibrated is necessary where high accuracy is required. Pyrometers for water gas machines are usually calibrated for a cold end temperature of 75° F., this having been found to be a fair average of the temperature close to water gas machines. When the cold end temperature does not agree with this standard, it is common practice to adjust the zero position of the millivoltmeter to compensate for the error. That is if the cold end temperature becomes higher than that at which the instrument was calibrated the indications on the galvanometer are lower than the actual temperature at the fire end, because the temperature difference for the same fire end temperature is smaller, and there is a smaller e. m. f. developed by the couple. In this case the zero position of the millivoltmeter is set higher than the zero mark to compensate for the difference, and *vice versa,* when the cold end temperature is lower than the calibration temperation temperature the zero position on the millivoltmeter is set lower than the zero mark to compensate for the difference.

In a note on cold end temperature correction published in *Bulletin No. 4* of the Bureau of Standards, December 15, 1913, Mr. Paul D. Foote has shown that the correction should be only a percentage of the difference, varying from 0.45 for 1,500° C. to 0.65 for 400° C. If we take 50 per cent. as the average correction factor, then adding or subtracting the difference would merely shift the error to the other side. This follows from the fact that the relation between the e. m. f. and the temperature difference is not linear, as shown by Holman's equation given in the previous chapter.

Use and Care of Thermo-Electric Pyrometers.

The thermo-electric pyrometer can be used with good results within the limits of the temperature range of the thermo-couple, in all places where the knowledge of the temperature existing at a point where the couple may be placed is useful to the operator. It is obvious, however, that they will not indicate the general temperature of a large structure, but only that at the point where the junction of the couple lies. If the temperature of this point is not representative of that of the whole structure, the use of this type of pyrometer is of but little benefit to the operator. They are, therefore, not to be recommended for observing temperatures of gas retorts settings or very long chambers of any kind where the heat may not be evenly distributed.

This type of pyrometer is used to a very large extent in the daily operation of water gas sets, as practically all the water gas made in this country is made in apparatus where from 1,200° F. to 1,600° F. is the temperature maintained in the checker work of the superheater, and not over 2,000° F. in the hottest part at the top of the carbureter.

It is customary to locate the thermo-couple in the water gas machine at the bottom of the carbureter, either between courses of checker brick, or in the gas space, and in the top of the superheater. Instruments with a temperature range up to 1,800° F. are well adapted to this service.

The accurate maintainance of the proper temperature in these parts of a water gas generator set means a tremendous saving in oil and generator fuel, and this can not be done without an accurate heat measuring device. A water gas plant can not be run efficiently without the knowledge of conditions, which such instruments give the operator. They are practically an indispensible auxiliary in the modern water gas plant.

These instruments either indicating or recording are not apt to get out of order if cared for properly, but care must always be taken to see that all electric contacts are clean and bright, and that the insulation of the wire leads is intact.

The indicating instruments should be located conveniently for the gas makers observation and properly illuminated. The dial should have open divisions and marked so as to avoid confusion in reading.

Both indicating and recording instruments, should be protected from excessive heat and vibration and especially when installed on the operating floor, should be provided with a glass front cabinet which will exclude dirt from the delicate mechanism.

Where one instrument serves more than one thermo-couple, a switch is required. This should also be installed in a protecting case and care should be given the contacts to see that errors are not introduced due to corrosion or loose connections.

Where a number of pyrometers are in use, it is advisable to employ a portable checking millivoltmeter, which is kept solely for this purpose, with its own fire end and leads. During cleaning or at some other time when the temperature is fairly constant the check couple is inserted in the casing pipe in place of the operating couple and if consistent readings are obtained on the check instrument, the indication of the operating instrument and couple is assumed to be correct. If a variation is found, provided the couples, leads and instruments are of standard resistance, the source of error may be located by substituting parts of the operating with the checking equipment. Care should be taken in testing that no error is introduced due to difference in cold end temperatures.

Fire ends which are in constant use, if they are not of the pencil type, should not be disturbed unless readings with test instrument and another fire end show that there is something wrong with them. The removal of even a perfectly good fire end after it has been used continuously a few days means its destruction, as the insulation will probably be broken unless great care is taken in handling it.

In order to calibrate the checking instrument, or where no checking instrument is available and it is desirable to obtain a check on a pyrometer, the use of some substance which has a definite melting temperature is necessary. Common salt, NaCl answers this purpose and its freezing temperatures, 1,472° F. is a point within the working range of water gas temperatures. A method of testing with salt is as follows:

A crucible which will contain salt to a depth of about 6 inches is heated in a furnace to a temperature over its melting point, say 1,600° F. The hot end of the thermo-couple is then immersed in the salt bath, and the crucible allowed to cool slowly.

The temperature as indicated on the instrument will decrease until, at 1,472° F. there will be a period of constant temperature as the salt solidifies, after which the cooling will again be apparent.

After correcting for cold end variations, the instrument may be adjusted, if necessary, to give correct indications.

Another method makes use of the melting point of wires of certain alloys. A number of turns of this wire are made around the fire end at the junction and the end is slowly and uniformly heated. At the melting point of the calibrated wire, a period of constant temperatures will be observed, after which a continued increase in temperature will be apparent.

Resistance Pyrometer.

In resistance pyrometers the principle involved is to measure the resistance of a metal when subjected to various temperatures. When a pure metal is heated, its resistance to electricity increases progressively with the temperature. Certain alloys, on the other hand, show practically constant resistance at all temperatures, as for instance, constantan, manganin and platinoid. For that reason only chemically pure metals are available for use in this type of pyrometer. For the lower temperatures up to 300° C., wires of the pure metals such as nickel, iron, silver, gold and copper may be used, but for temperatures above that the only feasible metal to use is platinum; and hence platinum is universely used for this purpose.

Measurements of the change in resistance in the pyrometer are made by either the differential galvanometer method or by the Wheatstone Bridge method.

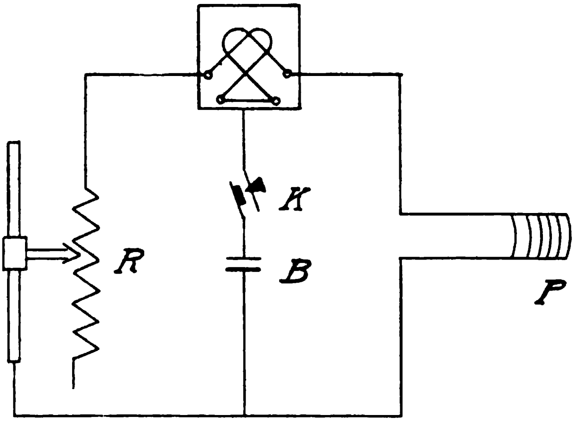


Fig. 19

Differential Galvanometer Method of Measuring Resistance

In the differential galvanometer method, the galvanometer possesses two windings so arranged that a current passing through one, tends to turn, the pointer in one direction, and through the other to cause a movement in the opposite direction. If the current in each winding simultaneously be equal, the pointer would remain at rest under the action of two equal and opposite forces. The amount of resistance necessary to obtain the condition of rest serves as a means of measuring the change in resistance due to temperature variations of the platinum coil. The circuit is arranged as shown in Fig. 19. The current passes from the battery *B*, through a divided circuit, one branch containing the adjustable resistance *R* and one coil of the galvanometer *G*, and the other the variable resistance of the pyrometer *P*, and the opposite coil. For reading the temperature, the resistance *R* is adjusted until on tapping the key *K*, no deflection is noted on the galvanometer showing that the current and consequently the resistance in each branch of the circuit is the same, from which it follows that resistance *P* is equal to resistance *R*. The adjustment of

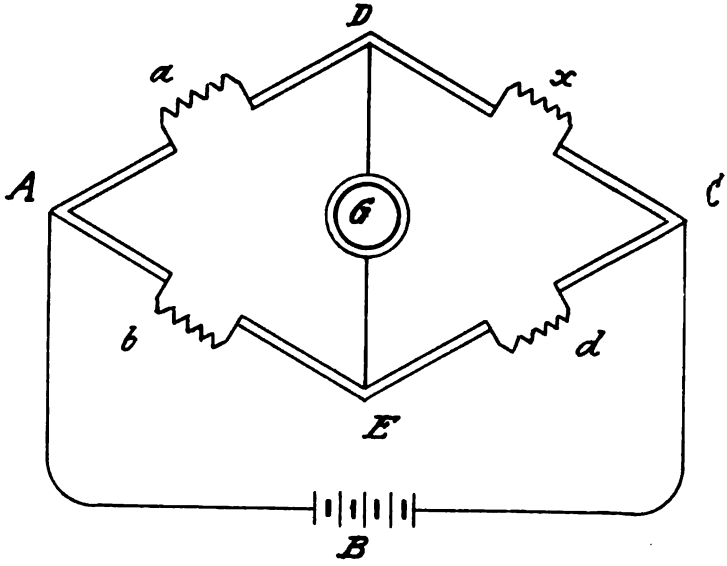


Fig. 20

Wheatstone Bridge Method of Measuring Resistance

R, therefore, measures the change in resistance *P* due to change of temperature.

The accuracy of this method depends upon the sensitiveness of the galvanometer, and also upon the extent to which the two coils may be regarded as truly differential, as the measurements evidently assume complete equality in resistance and effect on the movement of the galvanometer. Although very accurate readings may be obtained, the differential galvanometer is not as sensitive as the Wheatstone Bridge.

The principle of the Wheatstone Bridge of measuring the change in resistance is illustrated in Fig. 20; *B* is the battery and *G* is the galvanometer, *A* and *C* are known and equal resistances, *d* is an adjustable resistance, and *x* is the variable resistance. In this circuit when the resistance *d* is adjusted until no deflection is shown on the galvanometer, then no current is passing from *D* to *E*, and $\frac{a}{b} = \frac{x}{d}$, or $x = \frac{ad}{b}$. Since $a = b$, therefore $x = d$. The adjustment of the resistance *d* measures the change of resistance due to change of temperature.

Description of Resistance Pyrometer.

In a typical form of resistance pyrometer a coil of platinum wire is wound round the edges of a mica frame work, made of two strips of mica fastened at right angles so as to form a plus in section. This method of winding is due to Callendar, who discovered that mica was chemically inert towards platinum even at high temperatures. The leads, also of platinum wire, pass from the coil through mica washers to terminals fastened to a box-wood head. A second wire, not connected with the coil, but identical in length and diameter with the leads, is bent into two parallel branches, which are passed through the mica washers side by side with the leads, and are brought to a second pair of terminals in the head. The function of this wire is to compensate for changes in the resistance of the leads when heated, the resistance actually measured being in consequence that of the coil only. Fig. 21 shows the connections for a Wheatstone Bridge when this method of compensation is employed, a and b representing two equal fixed resistances, P, the pyrometer coil, x the leads, L the compensating wire, and d the adjustable resistance. G is a sensitive galvanometer and b the battery. When d is adjusted so that no deflection is observed on the galvanometer $\frac{a}{b} = \frac{x - P}{L - d}$: and since $a = b$, and $x = L$, P must equal d.

The platinum coil and leads are protected throughout by a porcelain tube, which in turn on account of being fragile is protected by an iron sheath. In place of the porcelain tube, fire-clay and silica tubing is sometimes used.

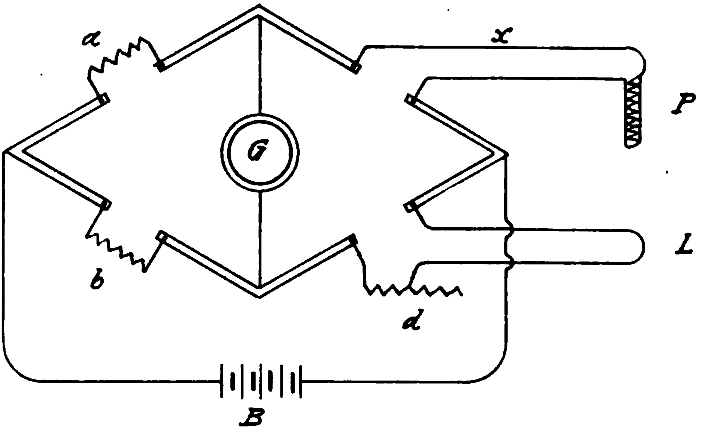


Fig. 21

Wheatstone Bridge as used with a Resistance Pyrometer

Indicators for resistance pyrometers are provided with a scale of degrees temperature corresponding to the change in resistance, but they are not automatic. They require considerable manipulation to obtain a temperature reading, which naturally restricts their field of usefulness to the laboratory.

Recorders for resistance pyrometers generally use the Wheatstone Bridge principle. They consist of a mechanism for restoring automatically the balance of resistances in the circuit in such a way as to record the varying resistances and corresponding temperatures directly on a chart.

Calibration of Resistance Pyrometers.

The change of resistance in a platinum wire is very nearly proportional to the change of temperature. This can be stated in the form of an equation:

$$t_1 - t_0 = C\,(R_1 - R_0)$$

where t_1, is any observed temperature, degrees C.

t_0, is zero temperature of the centigrade scale.

R, is the resistance of the wire at the observed temperature t_1.

R_0,is the resistance at zero centigrade.

C, is a coefficient depending upon the purity of platinum wire used.

It was found that up to 100° C. the value of C is constant for any given sample of platinum wire. For higher temperatures, however, the value of C is slightly increased. That is the change of resistance of 1 ohm has a larger value in degrees temperature at higher than at lower temperatures. The relation between the true temperature corresponding to a given change is resistance, and the temperature derived by using the constant value of C at 100° C. for the entire range of the pyrometer is shown graphically on Fig. 22 and is given by the following equation derived empirically by Callendar.

$$t - pt = d\left(\frac{t}{100} - 1\right)\frac{t}{100},$$

where t is the true temperature as indicated by an absolute temperature or gas scale thermometer, and pt is the temperature indicated by the platinum scale; d is a constant for any given sample of wire, having a value of 1.50 for pure platinum.

These equations are generally used for the calibration of the resistance pyrometer. The value of C in the first equation is determined by observing the resistance of 0° C. and 100° C. For the determination of d a third point at a higher range is necessary. The boiling point of sulphur (444.5° C.) observed under carefully specified conditions is the point generally employed for this purpose.

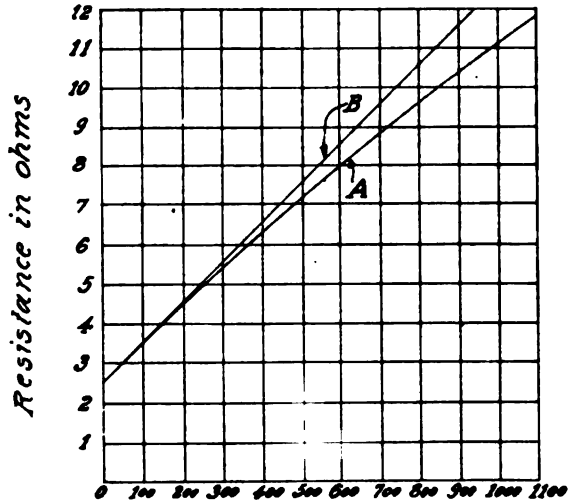


Fig. 22

Temperature Degrees C.
Relation between Resistance of Platinum
and Temperatures: "A" on Gas Scale
"B" on Platinum Scale

The resistance pyrometer is especially adapted for exact temperature readings as for instance for the accurate determination of melting points and boiling points of substances. In resistance pyrometers the readings are independent of the resistance of the wires used to connect the pyrometer with the indicator, as such wires are duplicated and opposed to each other in the measuring device, their resistance being thereby cancelled. These are the advantages of resistance pyrometers over the thermo-electric pyrometer. On the other hand they are more costly, more fragile, require more skilful attention, which makes them better adapted for laboratory use than for the industrial field.

Radiation Pyrometers.

Radiation pyrometers involve the principle of the transfer of heat from one substance to another by means of radiant energy. Any hot body radiates energy to its surroundings in a greater or less degree depending upon the difference in temperatures of the hot body and its surroundings. The rate at which a substance emits or takes up radiant energy depends upon the nature of its surface. A rough, black surface radiates and absorbs heat with greater freedom than any other. A polished body has the tendency to deflect the radiated energy. Therefore, in radiation pyrometers a black body is used to absorb the radiated energy from the hot body as a means of measuring its temperature. Numerous tests made by Stefan and Baltzmann showed that under black body conditions, the energy received by radiation from the heated substance varied as the fourth power of its absolute temperature, which is expressed by the formula.

$E = K (T_1^4 - T_2^4)$ where E is the total energy radiated by a body of absolute temperature T_1 to a body of absolute temperature T_2 and K a constant depending upon the units chosen. If E be expressed in watts per square centimeter, the value of K is 5.32×10^{-12}. The temperature of the receiving substance T_2 must be taken into account in that energy will be radiated back to the hot body and the net loss of energy will evidently be the difference between that which leaves it, and that which returns to it from the receiving substance.

For measuring the temperature, the energy radiated by the hot body is focused upon a very sensitive thermo-couple which is heated in proportion to the amount of energy incident upon it. The couple connected to a millivoltmeter will cause deflections proportional to the energy it received. From the relation between temperature and energy as given by the above equation, the deflections can be read in degrees of temperature directly. The thermal junction is generally made small in size and of low thermal capacity so as to respond rapidly, and be capable of giving sensitive indications. It is also coated with lampblack, so that practically all the heat waves, impinging upon it, may be absorbed, and the energy they represent utilized in producing a rise in temperature.

Description of Different Types of Radiation Pyrometers.

One of the most practical forms of radiation pyrometers consists of a concave mirror, which has a gilt reflecting surface, placed at one end of a metal tube, and is fastened to a rack which engages a pinion moved by a milled head, so that in turning the milled head a longitudinal movement is imparted to the mirror. A blackened thermal junction is suspended at the center of the cross section of the tube, from which leads are passed to the millivoltmeter.

The thermal junction is brought into focus by suitably moving the mirror to reflect the rays of heat upon the junction. In order to determine when the junction is in the focus of the mirror, an eye piece is fitted to the end of the tube, which enables the junction to be seen, and magnified through a hole in the center of the mirror. By means of an optical device placed near the junction, the image of the sighted object, produced by the mirror, is reflected in two portions to the eye piece. When the junction is exactly in the focus of the mirror, a circular image is seen round the junction; when out of focus the appearance presented is that of two semi-circles not coinciding laterally. The adjustment consists in moving the mirror until the separate semi-circles produce a continuous circle. The front end of the pyrometer is provided with a cap containing a shutter, so that the aperture may be made full or partial for low and high temperature indications respectively. The object of reducing the opening is to cut off a definite proportion of the radiations, and is used for very high temperatures, at which, with full opening, the indicator needle would be urged beyond the limits of the scale. For this reason the indicator is provided with two separate temperature scales, one referring to full, and the other to partial radiation. Although the intensity of radiations diminishes as the square of the distance, the quantity impinging on the junction is, within limits, independent of the distance. This arises from the property of concave mirrors with respect to the relation between the size of an image and the distance of the object producing it. If $r =$ the radius of the mirror, U the distance of the object, and V the distance of the image, both measured from the center of the mirror, the relation $\frac{1}{U} + \frac{1}{V} = \frac{2}{r}$ holds for a concave mirror, and when two of these are known the third may be calculated. Further if D be the linear dimension of an object, and D_1 that of its image, the relation $\frac{D}{D_1} = \frac{U}{r}$ also holds, and from these two expressions all the points arising in connection with the pyrometer may be determined.

Another type of radiation pyrometer is the fixed focus pyrometer. This type of pyrometer consists of a tube in which the mirror is placed, and is blackened internally so that no rays reach the mirror by reflection from it. The tube collects the radiations and concentrates them upon a sensitive thermo-couple which is connected to a galvanometer to measure the current generated in the thermo-couple. The conical mirror and the thermo-couple are fixed so as to be in focus of the heat surface at all times, which eliminates the possible error due to inaccurate focusing. The principle involved is that the amount of energy received by a concave mirror, through a fixed opening, will vary only with the temperature of the source because the area of the surface sending rays to the mirror, increases as the square of the distance. For illustration in Fig. 23, *C* is the mirror, *D* is a thermal junction fixed so as to be in focus of the opening *EF,* and *AB* is the heated surface. The lines joining *E* and *F* to the edges of the mirror intersect in a point *G,* and provided the lines *GE* and *GF* if produced fall within the heated surface AB, the quantity of energy falling on *D* will always be the same. The cross section of the cone *GAB* is a circle; and if *AB* be twice as far away from *G* as *EF*, the areas of the circles of which *AB* and *EF* are diameters will be in the ratio 4 : 1. But as *AB* is twice as far from *G* as *EF*, the intensity of its radiations will be as 1 : 4; and hence loss of radiating power is exactly balanced by increase in area. In other words the area increases with the square of the distance and the intensity varies inversely with the square of the distance. Although the necessity for focusing is obviated in this type of instrument, it cannot be used from so great a distance as the adjustable focus pyrometer.

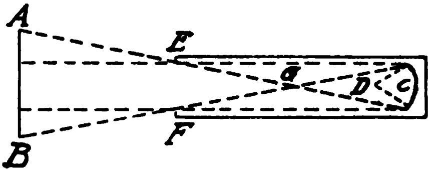


Fig. 23

Principle of Fixed Focus Radiation Pyrometer

The indicators and recorders for radiation pyrometers are similar to those used for the thermo electric instruments but are much more sensitive, as the e. m. f. developed by the radiation couple is very low. In the adjusting focus type the whole range covers only 4 millivolts, and the suspension type of galvanometer alone will accurately measure it. In the fixed focus type, covering a range of 12 millivolts, the high resistance bearing type galvanometer can be used as well.

Calibration of Radiation Pyrometers.

As the rays from the hot body are concentrated upon the thermo-couple of the pyrometer, an e. m. f. is generated, which is proportional to the difference in temperature between the hot and cold junctions. The temperature of the hot junction depends upon the intensity of the radiations. The temperature of the cold junction is that of the surrounding air. If the temperature of the hot junction is 90° C. and the temperature of the cold junction is 20° C., the deflection produced is due to their difference or 70° C.; the radiations having raised the temperature of the hot junction 70° C. above the temperature of its surroundings. If both hot and cold junctions are located so as to attain the same atmospheric temperature in the absence of radiations, a given quantity of energy impinging on the hot junction will always produce in it the same excess temperature, and will, therefore, give rise to the same deflections at all ordinary atmospheric temperatures.

The junction in radiation pyrometers are arranged to fulfill this condition so that the deflections on the indicator correspond to excess temperatures of the hot junction, which in turn are directly proportional to the energy received by the junction. In calibrating the instruments the fourth power low is applied. If E_1 and E_2 represent the energy radiated from a hot body at T_1 and T_2 absolute temperatures, and X represents the temperature of the surroundings receiving the radiations, $E_1 = K (T_1^4 - X^4)$ and $E_2 = K (T_2^4 - X^4)$

Then

$$\frac{E_1}{E_2} = \frac{K (T_1^4 - X^4)}{K (T_2^4 - X^4)} = \frac{(T_1^4 - X^4)}{(T_2^4 - X^4)}.$$

But as the reading of millivolts on the indicator are directly proportional to the energy received of R_1 and R_2 — millivolts due to E_1 and E_2 then R_1 and $R_2 = \frac{T_1^4 - X^4}{T_2^4 - X^4}$. Hence in order to calibrate the instrument, it is necessary to take one correct reading of some known temperature. The temperatures corresponding to other deflections of millivolts on the scale can then be calculated from the above formula.

As the whole scale hinges on this one reading, it is important that it be taken with a great degree of accuracy. To do this, an accurate resistance or thermo electric pyrometer may be used or a reading may be taken of the melting point of some metal, the temperature of which is known. If each whole millivolt and the corresponding temperatures are plotted, intermediate values may be deducted from the resulting curve.

This type of pyrometer is best adapted for high temperature readings beyond the limits of the thermo electric and resistance pyrometers. Also for measuring the general temperature of a large structure where the use of the above pyrometers becomes impracticable as, for instance, in measuring furnace temperatures, temperatures of retorts and ovens, and combustion chambers of gas benches and gas ovens.

The distinct advantages of radiation pyrometers are:

(1) That due to the fact that neither the couple nor any part of them is subjected to high temperature, the range of temperature over which they will read is very wide and their parts are not exposed to injury and will last a long time.

(2) They are easily portable.

(3) Their registration is affected by all the radiations which are collected and thrown on the thermo-couple; therefore, they average the temperature of the hot structure and do not show its hottest spot, unless it is possible to exclude all radiations except those from this hottest spot. This is sometimes a distinct disadvantage as well.

The principal disadvantage of this class of instrument are:

(1) They are not accurate when used in surroundings other than those in which they were calibrated.

(2) They are naturally affected strongly by the character of the atmosphere through which the radiations of the hot body come to the couple. For instance, smoke, dust, steam, or any other atmospheric condition which reduces the intensity of the radiations produces an error in the reading of the millivoltmeter because the force of the current from the couple is proportional only to the intensity of the light radiations which reach the couple. These instruments are then practically useless in a smoky place.

(3) Due to the fact that the radiations from all surfaces within the scope of the instrument are led to the couple, great care must be taken that the opening in the furnace wall, retort chamber or whatever is being observed, through which the in-

strument is sighted is big enough to allow the comparatively cool sides of the opening to be outside of the scope of the instrument. With small openings this means that the instrument must be very close, almost in contact with the hot wall of the furnace or there will be an error in the observation. A cold back wall in a retort or furnace will also have its effect upon the reading of the instrument. It will very often be found to be the case that large openings cannot be provided for use of the pyrometer because, due either to excessive radiation to the atmosphere or to inrush of cold air, the actual temperatures observed will be lower than is normally the case when everything is closed up tight.

(4) Distance from hot objects affects reading.

(5) Conditions of surface, whether dull or polished, has effect on readings. For instance, if an instrument is calibrated upon a heated black body, a correction must be made in readings of temperature made upon a body whose surface is shining or polished.

For firebrick material used in the gas works, the amount of radiation varies from the black body by which the pyrometers are usually calibrated, and observed temperatures will be lower than the true temperatures actually existing in the material. This variation has been found to be about 100° F. at 2,000° F.

Instruments of this type give excellent results in the laboratory, or in any work where they can be used with constant atmospheric and general local conditions, and when they can be calibrated under these conditions.

Optical Pyrometry.

Optical pyrometry consists of measuring the intrinsic brightness of the heated substance by a photometric method. The law connecting the intensity of the light waves emitted by a given body with the temperature of the body is approximately given by Rauch's formula:

$$\frac{I_1}{I_2} = \left(\frac{T_1}{T_2}\right)^x.$$

Where I_1 and I_2 are the intensities corresponding to absolute temperatures T_1 and T_2 and the exponent $X = \frac{25{,}000}{T_1}$. If T_1 is 1,000 degrees absolute, the brightness increases as the 25th power. This rapid increase in brightness for a small rise in temperature enables small increments to be readily observed; but a difficulty arises in practice owing to vast difference in brightness displayed by different substances at the same temperatures. However, it is possible, to obtain indications for any substance in terms of a black body. Thus if a heated solid possessed the same intrinsic brightness as a black body at a temperature of T_1 the apparent or black body temperature of the solid would also be called T_1. All that this signifies is that the condition of the solid is such that the light radiated is equal in intensity to that emitted by a black body at temperature T_1 and to obtain the true temperature of the solid, T_1 must be multiplied by a factor which expresses the ratio of its emissive power to that of a black body.

In all photometric methods, a standard light is employed. which should not vary in brightness and with which the light from the source is compared, all that is necessary is to bring the standard and the source to the same degree of brightness by suitable adjustment. Amongst the standards employed are carbon filament electric lamps, amyl acitate lamps, and for higher temperatures the center of an acetylene gas flame; each of which is capable of producing a fixed degree of brightness when used under specified conditions. A black body, at known temperatures, is compared with the standard used, thus furnishing a scale of black body temperatures to which indications of a given source may be referred. Above 1,000° C., the light becomes too dazzling to enable a proper comparison of the standard and source to be made, and absorbing glasses are then used to reduce the brightness. If a monochromatic glass is used, that is a glass which transmits a light of one wave length only, a well-defined relation is found to exist between the intensity of the transmitted light and the temperature of the source.

Optical pyrometers in most cases for temperatures above 1,000° C. involve the use of such glass. The relation between the wave lengths of light and the temperature of the black body source is given by Wein's formula:

$$J = C_1 L^{-5} \times e^{-C_2/LT}.$$

Where J = energy corresponding to wave length L; e = base of the natural system of logarithms; T = absolute temperature of the black body source, and C_1 and C_2 are constants, the value of which may be found by measuring at two known temperatures for light of a known wave length. This formula has proved to hold good for wave lengths which lie in the visible spectrum, but does not hold for longer waves. For the purposes of optical pyrometery, however, using red light of wave lengths about sixty-five millionths of a centimeter, Wein's law may be applied with great accuracy, and the calibration based upon this law agrees closely with the values obtained by other pyrometer methods.

Another form of writing Wein's formula is

$$\log 10\, J = K_1 + K_2 \frac{1}{T}.$$

Where $K = \log C_1 - 5 \log L$ and $K_2 = C_2 \frac{\log e}{L}$.

This simplified expression shows a linear relation between log J and $\frac{1}{T}$; and hence if the temperatures corresponding to two intensities be known, the results may be plotted on squared paper in the form of a straight line connecting T and J, from which line intermediate readings of temperature may be obtained for any given intensity.

Another form of Wein's law is to express it showing the ratio of two intensities, $\log \frac{J_1}{J_2} = \frac{C_2 \log e}{L} \left(\frac{1}{T_2} - \frac{1}{T}\right)$; where T_2 and T_1 are the absolute temperatures corresponding to intensities J_2 and J_1. The value of C_2 is 1,450,000, when L is expressed in millionths of a centimeter. Evidently if the ratio $\frac{J_1}{J_2}$ and the values of C_2 L and T_2 are known, T_1 may be calculated. When L is not known, as in the case of a piece of red glass for which its value has not been determined, two readings at known temperatures will establish the value of $\frac{C_2 \log e}{L}$ and all other results may then be calculated.

Practical forms of optical pyrometers fall under three heads.

1st. The standard light is constant, and the intensity of the light from the source varied in the instrument until equal to the standard. Pyrometers under this head are the Fery, Le Chatelier and Wanner.

2nd. The standard is varied until equal to that of the source which may be reduced in intensity if this exceeds that of the standard. The Holborn-Kurlbaum pyrometer comes under this head.

3rd. The color of the source is matched against a standard color, made to agree with that obtained in a given operation; or the source may be made to produce a standard color by a polarizing device. The types that come under this head are the Loviboud for the former, and the Mesure and Nouel for the latter.

The description and the principles involved by these forms of pyrometers are fully discussed in Bulletin No. 11 on Optical Pyrometery by the U. S. Bureau of Standards.

The practical application of optical pyrometers is for temperatures beyond the scope of the thermo-electric and resistance pyrometers, and where an occasional reading of temperature suffices, as there are no instruments on the market to give a continuous record. The industrial application of this type of pyrometer is the same as for the radiation type of pyrometer. There are, however, some decided advantages in the optical over the radiation type of pyrometer.

The advantages of the optical pyrometer are:

(1) Accuracy under practically all conditions which are usually met with, and ease in sighting.

(2) Absence of effect upon observations of smoke dust, etc., in surrounding atmosphere.

(3) Possibility of calibration, if necessary, upon each occasion of use.

(4) The fact that the size of the opening through which the hot structure is sighted at, need not be large.

(5) Ability to read temperature of hottest or coldest portion of an unevenly heated structure at will, obtaining maximum and minimum temperatures existing therein.

The disadvantages are:

(1) Presence of photometric sensibility; that is, due to the fact that the operation of the instrument involves the comparison and matching of intensity of light from two sources that the personal error of the observer is bound to enter in some extent.

(2) That these instruments cannot be made self recording.

(3) That they are heavy and not as easily portable.

(4) That they are prone to storage battery troubles.

(5) That they are complicated optical instruments quite easily gotten out of order and not easily repaired when they have done so.

To sum up: In the usual type of artificial gas plant, where temperatures are to be observed under 1,000° F., mercurial thermometers of many efficient types give the very best results. The mountings of the thermometers should be suited, however, to the character of the substance whose temperature is to be measured. For instance, a brass mounted thermometer should never be used for observations on crude coal gas, or a steel mounted one for those on temperatures of water.

If recording thermometers are to be used, those which use mercury as a medium are better than those using ether or gas, as they give readings over a greater range of temperature on the same chart. For observing temperatures between 1,000° F. and 1,800° F., base metal couple electric pyrometers are most convenient for use in operation of water gas apparatus, boilers, and in those portions of a retort bench beyond recuperator inlet.

For observation of retort setting temperatures, retort temperatures, furnaces, or other large structures where the temperature is not even throughout the structure and where the range of temperature is large and the maximum is comparatively high—2,500° F. to 3,500° F.—and where it is necessary to observe the maximum as well as the average temperatures, optical pyrometers are the only ones which will give accurate results.

On the same sort of work where only the average temperature of the structure need be shown and where the condition of the atmosphere is clear and the instruments work under the conditions under which they were calibrated, radiation thermocouple pyrometers will give accurate results and are easily handled. These are also very useful as recording instruments.

For laboratory work and experimental purposes, and where the temperatures are safely under the melting or disintegration point of platinum, resistance pyrometers can be used to advantage.

Another much used device for high temperature measurement is the familiar Seger cones. These may be very accurate but may also be made of some substances which are affected by the substance whose temperature is being measured. At best they are uncertain and inconvenient. They only show that the temperature existing was above that at which they were supposed to melt. They only indicate heat intensity at the exact spot where they are located.

Acknowledgement.

The Committee herewith acknowledges the favors of all companies and individuals who aided the members to accomplish the work of the Committee. Inquiries were made of practically all companies dealing in pressure gauges and pyrometers, and these cheerfully supplied the information requested.

The samples of equal area Pitot tubes and square root gauges used in the tests were specially made up by the Republic Flow Meters Company, of Chicago, and loaned to the

Committee, for which courtesy special acknowledgement is made herewith.

J. M. Spitzglass, *Chairman,*
W. V. A. Clark,
P. T. Dashiell,
S. J. Dickey,
O. B. Evans,
F. J. Ikena,
H. C. Wehnert.

Mr. O. B. Evans (Philadelphia): (Written discussion communicated.) Mr. Spitzglass has devised a most ingenious form of Pitot tube and differential gauge, and the trial made by the various members of the Committee would indicate that the coefficient for the tube is almost constant. As I understand the device, however, it works upon the principle of averaging the square root of the different pressures existing in the interior of the main.

Since the Pitot tube is connected to a gauge, there is no flow of gas in that portion of it outside of the main; it would seem to me, therefore, that the pressure transmitted to the gauge would be that at the opening nearest to the gauge, that any difference in pressure between this opening and any other, would merely produce local currents, the effect of which would not be transmitted to the gauge. Mr. Spitzglass has undoubtedly considered this phase of the matter, and can explain how the tube does actually average the square roots of the pressures.

In the chapter devoted to thermo-electric pyrometers, the relative advantages and disadvantages of the low and high resistance types are mentioned. Can Mr. Spitzglass tell us the error in reading which would occur with both a high and a low resistance instrument, assuming a rise in temperature of the leads and instruments of, say 25° above that at which they were calibrated?

Mr. J. M. Spitzglass (Rejoinder to Mr. Evans): In reply to the question raised by Mr. Evans, I would say that the Pitot tube theoretically averages only the different pressures existing in the interior of the pipe, and not the square roots of those pressures. There may be a slight difference between these two quantities which can be easily neglected. In the examples given on pages 185, 186 and 193 I used the average velocity in order to simplify the comparison. If the comparison was made between the corresponding pressures, the difference between the two cases would still be practically the same, though the actual figures would be somewhat different.

To prove that the tube does transmit the average pressure, let us consider a simple case of two similar openings in a tube, one opening facing the impact of a high velocity V_1, and the other opening facing the impact of a low velocity V_2. It is required to determine the velocity pressure existing at any point inside the tube.

Since there is a pressure difference between the two points communicating with the tube, there must be a local current flowing inwards at V_1 and outwards at V_2, the flow through both openings being equal and opposite in direction. The flow through the tube itself is at right angles to the two openings, and, therefore, the velocity of the local current is changed into pressure when the direction of the current is changed.

Let U_1 and U_2 represent the velocities of the local current; then, from Bernsuilli's theorem, the velocity pressure inside the tube due to the first opening will be

$$\frac{V^2_1}{2g} - \frac{U^2_1}{2g}$$

and due to the second opening the pressure will be

$$\frac{V^2_2}{2g} + \frac{U^2_2}{2g}$$

and since U_1 and U_2 are equal, therefore, the pressure inside the tube is just as much higher than V_2 as it is lower than V_1, or the pressure inside the tube is equal to

$$\frac{1}{2}\left(\frac{V^2_1}{2g} + \frac{V^2_2}{2g}\right)$$

which is the average pressure of the two openings.

The same reason applies to any number of openings in the tube, that is to acquire a state of equilibrium, as is the case in the portion of the tube outside the main, the pressure must be the average of all the openings so that the flow inwards will be balanced by the flow outwards.

Mr. Evans inquired what will be the error in reading the thermo-electric pyrometer, both of the high resistance type and of the low resistance type, assuming a rise in temperature of the leads and instruments of 25° F. above that at which they were calibrated. This error can be determined approximately as follows:

Assuming the leads to consist of 500 feet of No. 12 gauge copper wire, the resistance of the leads and connections will be about 1 ohm. The resistance of the moving coils in the instruments which must be of copper wire, is about 2 ohms. The internal resistance of the instrument is usually made up of some alloy which does not change in resistance with the change in temperature.

The resistance of copper wire increases 1 per cent. for every 4.5° F., and for 25° F., the 3 ohms of copper wire resistance will be increased to 3.165 ohms. If the total resistance of the circuit is only 5 ohms, the current passing through the instrument and the corresponding indication, will be reduced 3.3 per cent. $(0.165 \times 100 \div 5 = 3.3)$. In a high resistance instrument of, say, 100 ohm circuit, the error will be only a small fraction of 1 per cent. $(0.165 \times 100 \div 100 = 0.165)$. The nature of the error is such that when the temperature of the leads and instrument is increased, the temperature indicated by the instrument is lower than the true temperature, approximately, in proportion to the reduction of current flowing through the instrument.

Mr. L. B. Jones (San Francisco): (Written discussion communicated.) I have read with a great deal of interest the report of the Committee on Gas Works Auxiliaries, and want to congratulate the members of this Committee on their excellent work.

The general desire on the part of most gas men for a more accurate knowledge of conditions and the means provided by such work as this Committee has accomplished—of economically and accurately measuring temperature, pressure and flow—marks an epoch in the business.

The gas business has surely passed the days of a guesswork art, and must hereafter be classed as a science. The Pitot tube and square root differential gauge unquestionably provide an inexpensive and accurate means of testing the flow of liquid and gases in the gas works.

In selecting meters for the control of recent oil gas generating apparatus in San Francisco, the advantages and disadvantages of the several types were carefully considered. The "Venturi" meter was finally selected as the type best suited to fill the requirements. These meters are used as control meters to regulate the flow of air, oil, steam, and catalytic gas to the generators, and the production of gas from the generators. Absolute accuracy of these meters was of less importance than consistent and quick accurate reading of relative quantities.

Two 3-inch meters are used with single tube manometers for the control of the rate of introduction of the oil for gas-making. In conjunction with these meters, displacement meters are used in the same lines. The displacement meters integrate the quantity of oil passed, but do not indicate the rate of flow which in oil gas manufacture is a very important function.

A 6-inch tube is inserted in the main steam line and connected to a single tube manometer before the operator. A 24-inch tube is located at the outlet of the last secondary scrubber for measuring the gas produced by the two generators in this unit. This tube is connected to a register located on the operating floor. This register indicates and records the rate of flow, or in this case, the rate of production, and also integrates the total quantity passed.

Displacement meters are used to measure the station production, so that the "Venturi" is an operating control meter.

Our experience has been that this information: the rate of production for each minute of the run, and relations of one run to the next, is indispensible to high efficiency of operation. The meters in this installation have been satisfactory for the purpose for which they were intended, but represent an expenditure far in excess of a similar Pitot tube installation. Our experience has been that the greatest advantage of the Venturi meter for this class of work is that, unlike the Pitot or orifice meters a high differential pressure is induced equal to four to six times the static loss through the meter. This permits of quick and accurate regulation of the supply to maintain a definite differential pressure and also permits the use of a device for integrating the total quantity.

In this installation we have also an extensive pyrometer installation. Each generator is equipped with eight platinum-platinum rhodium thermocouples connected through a selective switch to a galvanometer on each operating table. Four couples in each set are used for regular operation; the other four leads for testing or experimental work. The selective switches are sixteen pole and the two galvanometers are cross-connected so that on either galvanometer can be indicated the temperature of any couple in either set. This eliminates the possibility of an error due to the galvanometer, as it is not likely that both instruments would be in error at the same time. The element of the thermocouple is encased in a Marquardt-Mass tube, and this again is installed in a fire tile. A 3-inch hole is drilled into a fire tile 4 inches square to within ½ inch of the end. This tile is laid in the lining of the generator with the closed end projecting about 6 inches inside the lining. This greatly protects the couple and does not introduce an appreciable error.

Tests of the same temperature simultaneously with and without the protecting tile case showed a difference only in time, the cased couple responding to a change in temperature about one minute later. As the total range of temperature from beginning to the end of a run does not exceed 70° F.

in the chamber and 50° F. in the checker brick in the modern oil gas apparatus, this time discrepancy is no great disadvantage.

THE PRESIDENT: The next is the report of the Committee on Meter Connections.

REPORT OF THE COMMITTEE ON METER CONNECTIONS.

We beg leave to submit the following as the report of the Committee on Meter Connections. As the members who compose this Committee are widely separated and as the Committee was not organized until late in the year, its work is incomplete and it has been decided to submit such data as has been accumulated, with some recommendations in connection therewith, with a view to inviting interest and discussion in regard to this subject.

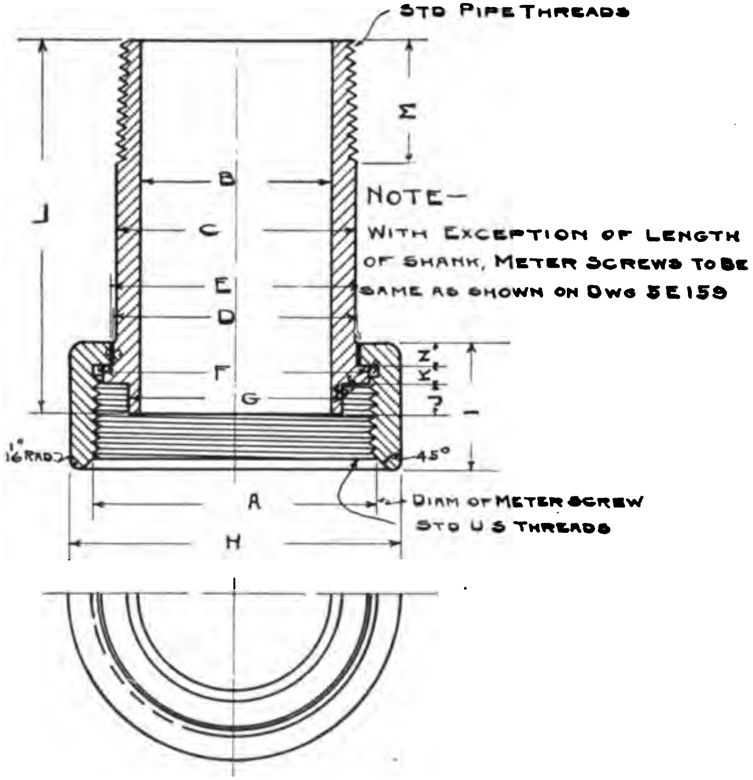
The plan and scope of the Committee originally contemplated a report on meter connections, including meter cocks, and it was later suggested that the subject of meter shelves be also included, but, as the time was short, and in justice to the subject to which the Committee had originally been appointed, it was decided that it would be better not to take up the matter of meter shelves. However, it was suggested that the Technical Committee of the Illinois Gas Association could be of assistance in this matter. Mr. C. E. Reinicker, Chairman of the Technical Committee of the Illinois Gas Association, very kindly appointed a committee to take up the subject of meter shelves and work in connection with this Committee.

The different methods used in setting meters vary almost as extensively as the number of companies themselves. Practically all of the large companies have been communicated with, and later on in the report, line drawings are shown of some of the various methods used in setting meters, and short comments are made in regard to them. This report is made not so much in the way of recommendation, but with the desire of bringing out a discussion which will be of value to the Institute. The Committee did not deem it advisable to recommend any of the so-called standard methods of connecting meters, for the reason that conditions under which meters are set, or services, risers, special devices and safety features installed, as required by law, insurance underwriters, or by the management, are not similar in the various cities or towns, or in the various sections of the country. The most that the Committee can do is to suggest the use of certain combination of fittings in the making up of the inlet and outlet connections in order to enable the meter swivels to face up properly with the meter screws, the faces of which are seldom in the same plane; the use of certain special devices, or methods of tying the inlet and outlet meter connections together in order to relieve the meter screws of any severe strains; methods of supporting the meter and the meter connections, and a set of specifications for meter cocks.

It would seem desirable at this time to invite discussion in the use of all sizes of malleable iron meter unions, either black or galvanized, in view of the increased cost of brass castings. A number of gas companies now use malleable iron meter unions, although some companies, it is understood, have discontinued this practice owing to the difficulty experienced in obtaining unions that were not porous. It would seem, however, as if malleable iron unions free from flaws and sand holes could be made at a reasonable cost. This is a subject which should interest the members of the Institute and one which should bring forth considerable discussion.

The cap on the present standard brass meter union is faced all over. It would seem as if this facing on the outside of the cap is unnecessary inasmuch as no gas company, as far as we know, uses fixed jaw wrenches on the octagonal caps. One large gas company has designed a round cap to be supplied with the meter union swivel instead of the finished octagonal cap. It would seem as if this round cap should be cheaper to manufacture and would offer difficulties to gas consumers who attempt to disconnect gas meters for various reasons, but would offer no disadvantages to the gas company employees who now use pipe wrenches on the octagonal caps.

Herewith is shown a cut of the proposed round cap, with dimensions.


STD PIPE THREADS
M
J
B
C
E
D
F
G
NOTE—
WITH EXCEPTION OF LENGTH OF SHANK, METER SCREWS TO BE SAME AS SHOWN ON DWG 5E159
Z
X
Y
1/16" RAD
45°
A
H
DIAM OF METER SCREW
STD U S THREADS

Dimensions of Proposed Malleable Iron Meter Unions.

Size	3 light	5 light	10 light	20 light	30 light	45 light	60 light	80 light	100 light	150 light	200 light	250 light
A	63/64	1 1/8	1 7/16	1 53/64	2 3/64	2 17/64	2 7/16	—	3	3 1/2	3 1/2	—
B	7/16	19/32	13/16	1 1/32	1 11/32	1 17/32	1 9/16	—	1 31/32	2 13/32	2 13/32	—
C	11/16	27/32	1 1/16	1 5/16	1 21/32	1 29/32	1 29/32	—	2 3/8	2 7/8	2 7/8	—
D	23/32	7/8	1 3/32	1 11/32	1 11/16	1 15/16	1 15/16	—	2 7/16	2 15/16	2 15/16	—
E	3/4	29/32	1 1/8	1 3/8	1 23/32	1 31/32	1 31/32	—	2 1/2	3	3	—
F	7/8	1	1 5/16	1 5/8	1 29/32	2 1/8	2 1/4	—	2 13/16	3 5/16	3 5/16	—
G	21/32	3/4	1	1 5/16	1 1/2	1 45/64	1 29/32	—	2 7/32	2 5/8	2 5/8	—
H	1 1/4	1 7/16	1 3/4	2 1/8	2 3/8	2 5/8	2 7/8	—	3 1/2	4	4	—
I	21/32	11/16	3/4	7/8	31/32	1 1/32	1 1/32	—	1 1/4	1 19/32	1 19/32	—
J	5/32	5/32	5/32	3/16	1/4	1/4	1/4	—	1/4	5/16	5/16	—
K	1/8	1/8	1/8	5/32	5/32	5/32	5/32	—	3/16	9/32	9/32	—
L	2 1/8	2 3/16	2 5/16	2 3/4	2 7/8	3	3	—	3 13/16	4	4	—
M	9/16	9/16	11/16	3/4	7/8	1	1	—	1	1 1/4	1 1/4	—
N	3/32	1/8	1/8	5/32	3/16	3/16	3/16	—	1/4	1/4	1/4	—
Threads per inch on screw	18	12	11 1/2	11 1/2	11 1/2	11 1/2	11 1/2	—	11 1/2	11 1/2	11 1/2	—
Swivel standard pipe threads for	3/8	1/2	3/4	1	1 1/4	1 1/2	1 1/2	—	2	2 1/2	2 1/2	—

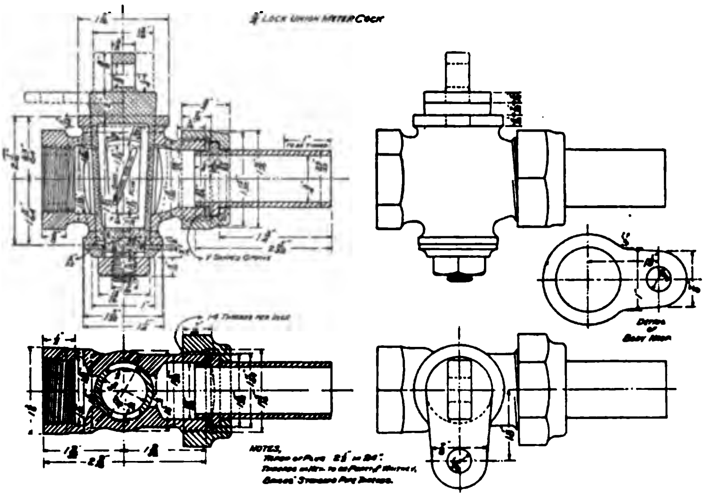
METER COCKS.

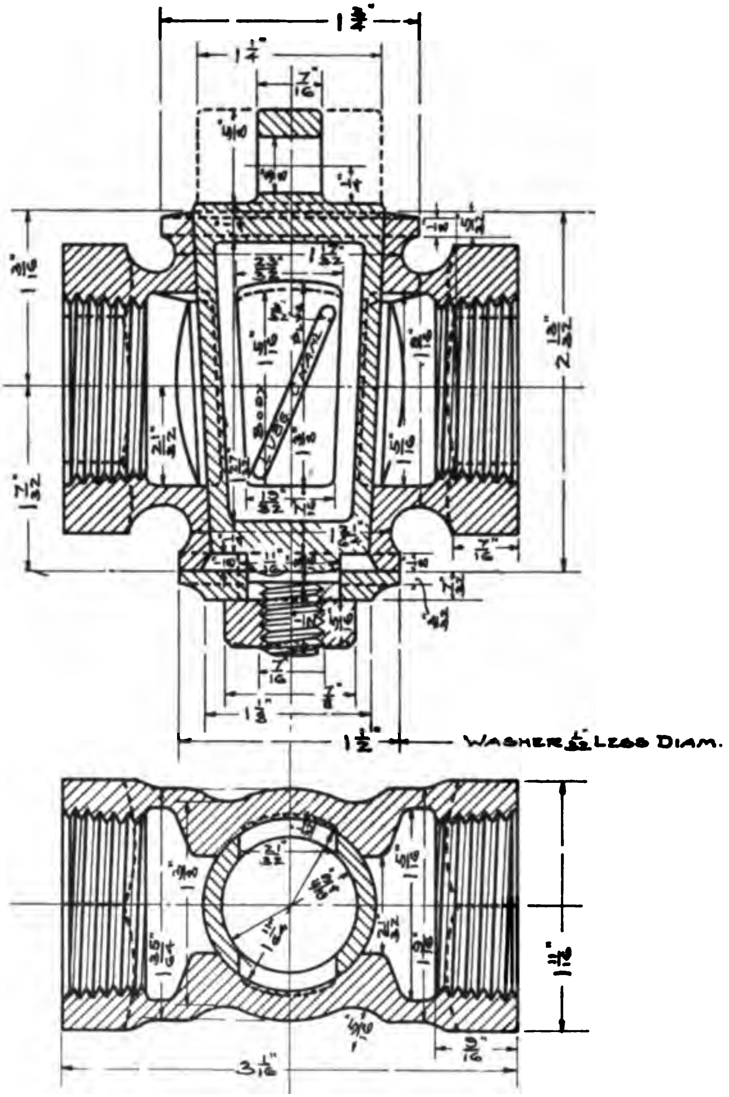
A material saving could be effected by using meter cocks made of iron bodies and brass plugs, instead of the all-brass type which is generally used by gas companies. The dimensions of the meter cocks from ¾ inch to 2 inches inclusive could remain the same for the iron and brass cock. Several gas companies use iron body and brass plug cocks for services, and if this type of cock answers the severe requirements of a service cock, there does not appear to be the least doubt but that it would answer as a meter cock equally as well as does the all-brass cock.

Inasmuch as The United Gas Improvement Company has gone into the matter of standardizing meter cocks extensively, it would seem well to recommend that the type of cock adopted by this company receive consideration with a view to recommending it as the standard meter cock. Sketches of these cocks are appended.

The United Gas Improvement Company's specifications for the manufacture of brass cocks call for the following mixture of all new metals:

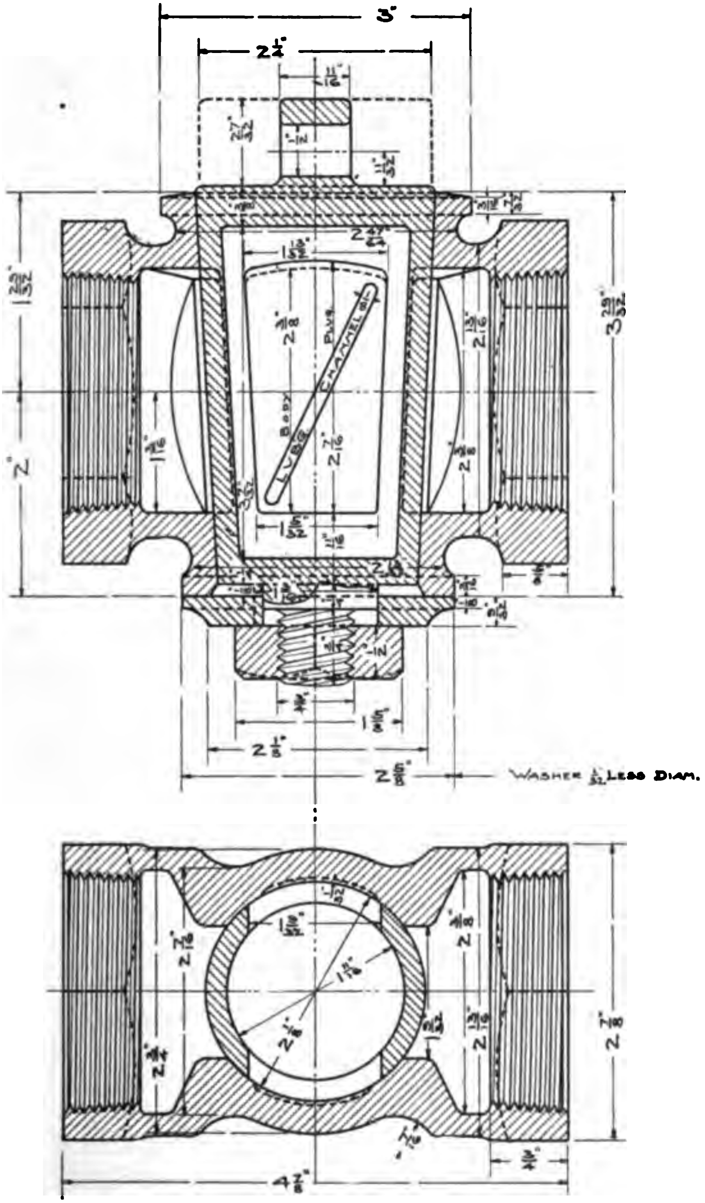
	Per cent.
Copper	76
Spelter (zinc)	16
Lead	6
Tin	2
Total	100


3/4" Lock Union Meter Cock
14 Threads per Inch
Detail of Body Hook
NOTES,
Taper of Plug 2 1/2" in 24":
Threads on Nipple to be Parts of Whitworth,
Briggs' Standard Pipe Threads.



Standard 1″ Double-Hex Meter Cock.

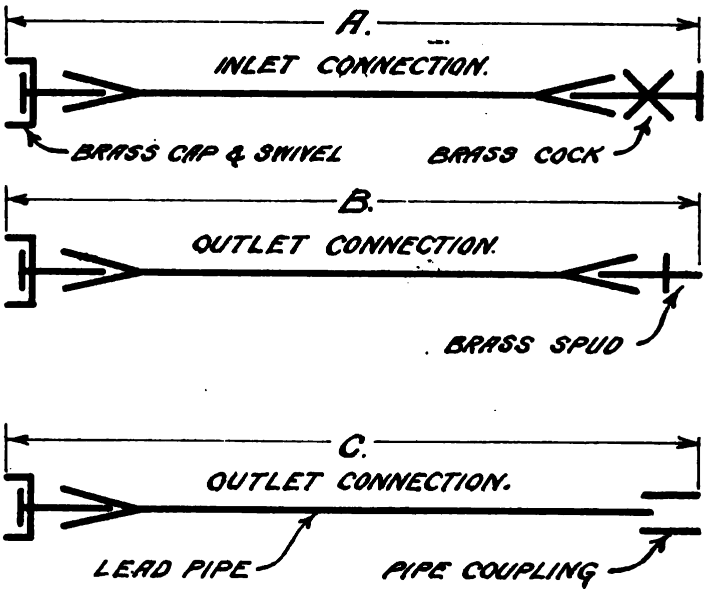
NOTES.— Size and name of cock on one side and maker's initials on opposite side. No letters or figures shall be countersunk. Taper or plug 2½″ in 24″. Tap to correspond with Pratt and Whitney, Briggs' standard pipe threads. See sheet 5E 185.



Standard 2" Double-Hex Meter Cock.

Notes.—Size and name of cock on one side and maker's initials on opposite side. No letters or figures shall be countersunk. Taper of plug 2½" in 24". Tap to correspond with Pratt and Whitney. Briggs' standard pipe threads. See sheet 5E 185.

LEAD METER CONNECTIONS.



A,-B,& C. TO BE 15 INCHES FOR 3 TO 45-LIGHT CONNECTIONS, INCLUSIVE, OR FOR 3 TO 10 LIGHT, TO BE ONLY 12 INCHES?

Lead Meter Connections.

The so-called "standard" lead connections shown by the sketches "A" and "B" (3 to 45 light connections as per drawings) all measure 15 inches over all. This probably offers an advantage, from the fitters' standpoint, over the lead connections of variable over-all dimensions resulting from the use of uniform lengths of lead pipe for all sizes of connections, although in the case of the 3, 5 and 10 light connections of this uniform over-all dimension, the connections are longer than they need be, and, in consequence, are more expensive than the shorter connections. An over-all length of 12 inches would probably give suitable lengths of lead pipe in the 3, 5 and 10-light lead connections.

The plain meter cocks used in making up lead inlet connections should be similar in all respects, with the exception of the tinned shank to the "double hex." meter cocks. The tinned tapered shanks of the meter cocks should be of about the same length for all sizes of cocks.

Ordinary pipe sockets, or couplings, may be soldered to one end of the lead pipe of the outlet connections for 3, 5 and 10 light meters, as shown by sketch "C," instead of using the brass male solder nipple, shown by sketch "B." The use of the coupling does not afford as strong a joint as does the solder nipple, but in practice it has been found to be sufficiently strong and to cost less than the solder nipple joint.

The lead pipe used in making lead meter connections, is graded by the weight per foot as follows:

WEIGHT PER FOOT OF LEAD PIPE.

Size of lead pipe	Size of meter connection	Size of plain cocks	Medium	Light	Extra light
5/8"	3 lt.	3/4"	2 lb., 0 oz.	1 lb., 12 oz.	1 lb., 4 oz.
3/4"	5 "	3/4"	2 " 8 "	2 " 0 "	1 " 8 "
1"	10 "	1"	3 " 4 "	2 " 8 "	2 " 0 "
1 1/4"	20 "	1 1/4"	3 " 12 "	3 " 0 "	2 " 8 "
1 1/2"	30 "	1 1/2"	5 " 0 "	4 " 0 "	3 " 8 "
1 3/4"	45 to 60 lt.	1 1/2"	5 " 8 "	4 " 8 "	3 " 12 "

Unless otherwise specified, the makers of lead meter connections use "extra light" lead pipe. This grade of pipe seems to fill all ordinary requirements, as no weight is, or should be, supported by the connections.

The cup joints, or the sweated joints are sufficiently strong for attaching the fittings to the ends of the lead pipe, so that there should be little, or no occasion for making wiped joints on the lead pipe. An ordinary fillet solder joint may be used when the end of the lead pipe is inserted in a pipe coupling, or socket.

The straight lead connection is recommended in preference to the side, or shoe connection, or the connection with ell swivels, inasmuch as it is cheaper, stronger, and will result in uniformity in the manufacture of connections.

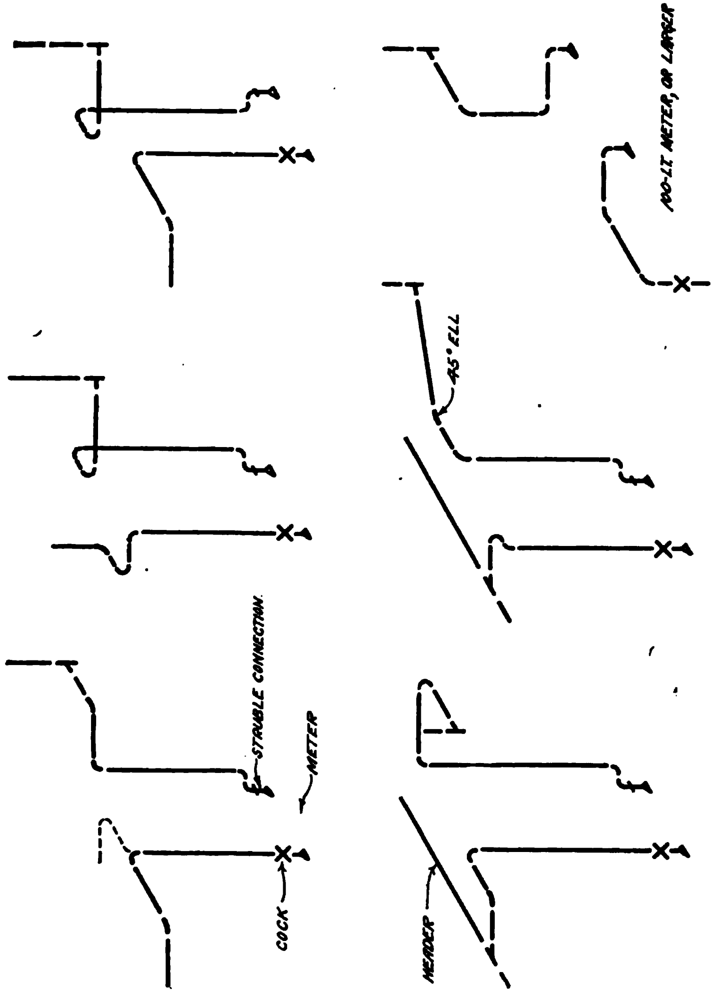
The tendency is for gas companies to discontinue the use of lead outlet connections, especially above the 10 light size, and to discontinue the use of lead inlet connections for all sizes, and to use all-iron connections and suitable swing joints, and, in addition, a solid or a split tie-in between the inlet and the outlet piping in order to relieve the meter screws and column seams of all avoidable strains.

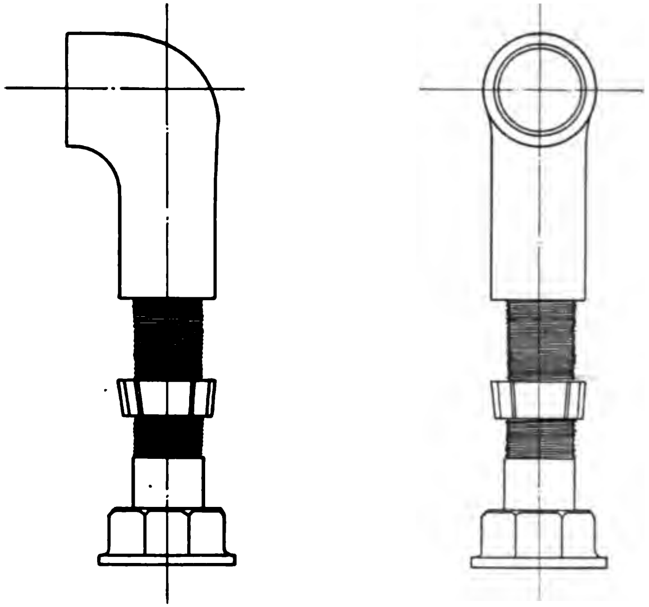
THE CONSOLIDATED GAS CO. OF NEW YORK. PRACTICE.

A vertical adjustment of the outlet connections could be obtained by using two ells at the top of the vertical drop to the meter union. In this event, an ordinary meter swivel and cap could be used instead of using the "Struble" connection and ell. This would require one less joint to be kept gas tight and would be cheaper in first cost.

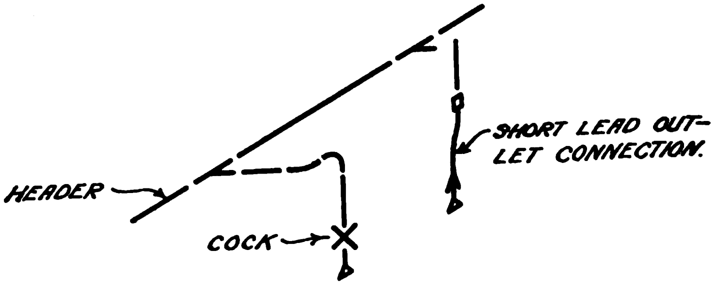
The outlet connection shown for 100 light meters, and larger, permits of adjustment for variable widths of meter but not for height. Double swings should be provided in the outlet connection to enable the outlet swivel to be raised or lowered, and still face up approximately with the meter outlet screw.

A drawing of the "Struble" connection is shown in connection with this sketch.


100-LT. METER, OR LARGER
45° ELL
STRUBLE CONNECTION
METER
COCK
HEADER



⅜ x ½″ Strubel Connection.



NOTE.—The short lead outlet connection will provide adjustment for variable width between meter screws and, to a limited extent, for variation in height. The inlet connection will provide adjustment toward the front, back, inlet or outlet to enable the facing of the inlet union, but will not provide for vertical adjustment. The use of three ells in the inlet connection, instead of two, as shown, would provide for a limited adjustment in a vertical direction.

PHILADELPHIA PRACTICE.

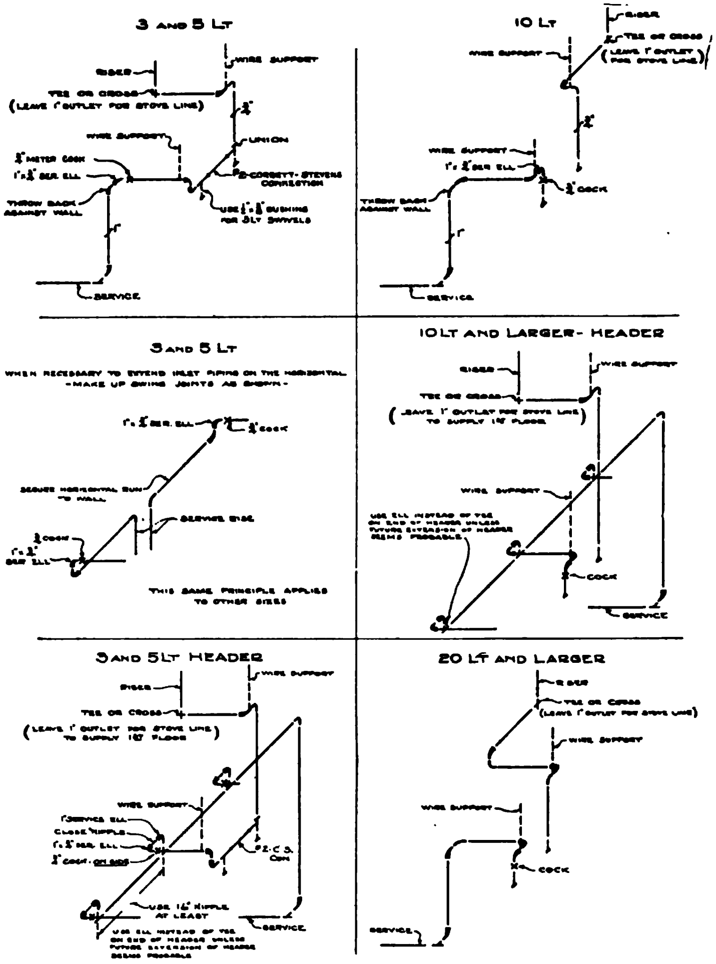
The method of connecting 3 to 200 light meters, as shown by the following sketches, calls for the use of all-iron inlet and outlet connections having two double swing joints on the inlet side and one double swing joint on the outlet side.

The two-piece, cast iron tie-in between the inlet and outlet meter unions is first adjusted, when setting 3 and 5 light meters, to the meter to be set; the two parts are bolted together and then attached to the inlet piping after which the outlet piping connections are made up.

When a meter is changed on this type of connection, the two-piece tie-in is removed and refitted to the screws of the meter to be set, after which it is replaced in position on the piping connections.

The connection shown for meters larger than the 5 light size permits of all necessary adjustment of the piping to the variable widths between meter screws, and enables the fitter to face up the meter screws and meter unions fairly well and to level the meter without straining the connections, meter screws, or column seams.

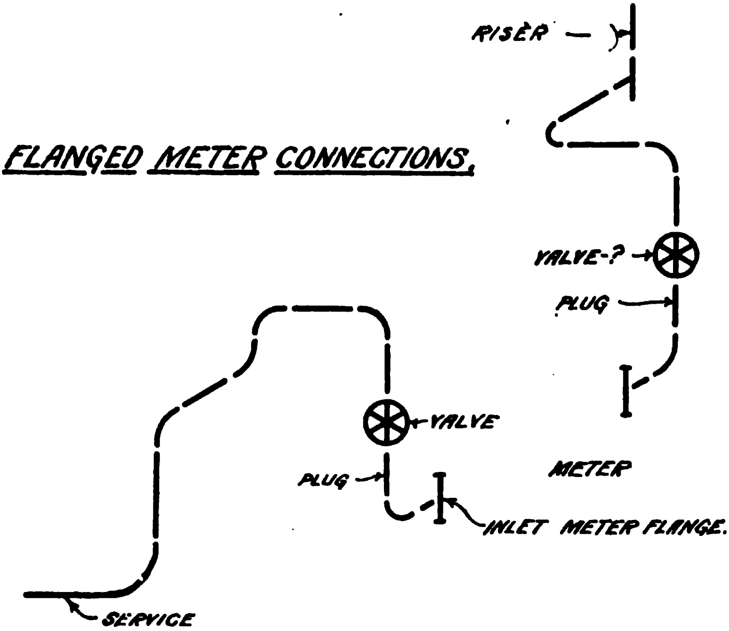
All meters set in Philadelphia are supported by means of hanger shelves, two-piece adjustable shelves mounted on a back board placed on the wall below the meters, or are set on meter tables, or on the floor.


3 AND 5 LT
RISER
WIRE SUPPORT
TEE OR CROSS
(LEAVE 1" OUTLET FOR STOVE LINE)
¾"
WIRE SUPPORT
UNION
¾" METER COCK
1" x ¾" SER. ELL
#2 CORBETT-STEVENS CONNECTION
THROW BACK AGAINST WALL
USE ¾" x ⅝" BUSHING FOR 3LT SWIVELS
1"
SERVICE
10 LT
RISER
TEE OR CROSS
(LEAVE 1" OUTLET FOR STOVE LINE)
WIRE SUPPORT
¾"
WIRE SUPPORT
1" x ¾" SER. ELL
¾" COCK
THROW BACK AGAINST WALL
1"
SERVICE
3 AND 5 LT
WHEN NECESSARY TO EXTEND INLET PIPING ON THE HORIZONTAL -MAKE UP SWING JOINTS AS SHOWN-
1" x ¾" SER. ELL
¾" COCK
SECURE HORIZONTAL RUN TO WALL
SERVICE RISE
¾" COCK
1" x ¾" SER ELL
THIS SAME PRINCIPLE APPLIES TO OTHER SIZES
10 LT AND LARGER - HEADER
RISER
WIRE SUPPORT
TEE OR CROSS
(LEAVE 1" OUTLET FOR STOVE LINE TO SUPPLY 1ST FLOOR)
WIRE SUPPORT
USE ELL INSTEAD OF TEE ON END OF HEADER UNLESS FUTURE EXTENSION OF HEADER SEEMS PROBABLE
COCK
SERVICE
3 AND 5 LT HEADER
WIRE SUPPORT
RISER
TEE OR CROSS
(LEAVE 1" OUTLET FOR STOVE LINE TO SUPPLY 1ST FLOOR)
WIRE SUPPORT
1" SERVICE ELL
CLOSE NIPPLE
1" x ¾" SER. ELL
¾" COCK - ON SIDE
#2 C.S. CON
USE 1½" NIPPLE AT LEAST
SERVICE
USE ELL INSTEAD OF TEE ON END OF HEADER UNLESS FUTURE EXTENSION OF HEADER SEEMS PROBABLE
20 LT AND LARGER
RISER
TEE OR CROSS
(LEAVE 1" OUTLET FOR STOVE LINE)
WIRE SUPPORT
WIRE SUPPORT
COCK
SERVICE

STANDARD METER CONNECTIONS

NOTE.-
THESE CONNECTIONS CONTROL ALL
METERS EXCEPT THOSE WITH FLANGES

FLANGED METER CONNECTIONS.



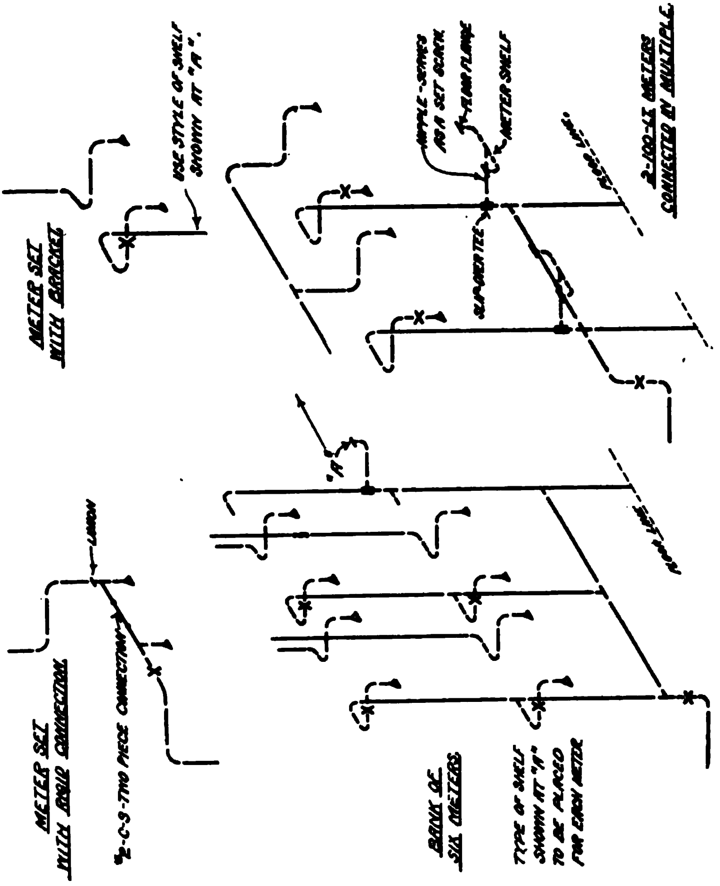
NOTE :-

PLACE A VALVE ON THE OUTLET CONNECTION WHEN MORE THAN ONE METER IS CONNECTED TO THE SAME SYSTEM OF PIPING.

A 1/4 IN., OR 3/8 IN. SCREW PLUG SHOULD BE INSERTED IN THE METER CONNECTIONS, BETWEEN THE VALVES AND THE METER, IN ORDER TO DETERMINE IF VALVES ARE CLOSED BEFORE ATTEMPTING TO DISCONNECT THE METER.

MINNEAPOLIS GAS LIGHT CO. CONNECTIONS AND REMARKS.

The connections for the meter set on the two-piece tie-in connection, shown in the sketches, do not permit of any vertical adjustment which will enable the meter to be leveled. An additional ell should be provided in the outlet connection to enable proper facing of the union joint on the outlet member of the two-piece connection.


METER SET WITH BRACKET
USE STYLE OF SHELF SHOWN AT "A".
NIPPLE-SCREWS FOR A SET SCREW
FLOOR FLANGE
METER SHELF
FLOOR LINE
2-100-LT. METERS CONNECTED IN MULTIPLE.
SLIP-OVER TEE
"A"
FLOOR LINE
UNION
METER SET WITH RIGID CONNECTION
2-C-S-TWO PIECE CONNECTION
BANK OF SIX METERS
TYPE OF SHELF SHOWN AT "A" TO BE PLACED FOR EACH METER

The position of the meter cock as shown, necessitates the taking up of too much horizontal space by the meter inlet piping.

The other inlet and outlet connections do not comprise sufficient swing joints to enable the meter union swivels and the meter screws to face sufficiently to prevent strains on the meter screw joints and meter column seams, when making up the meter union joints under certain conditions.

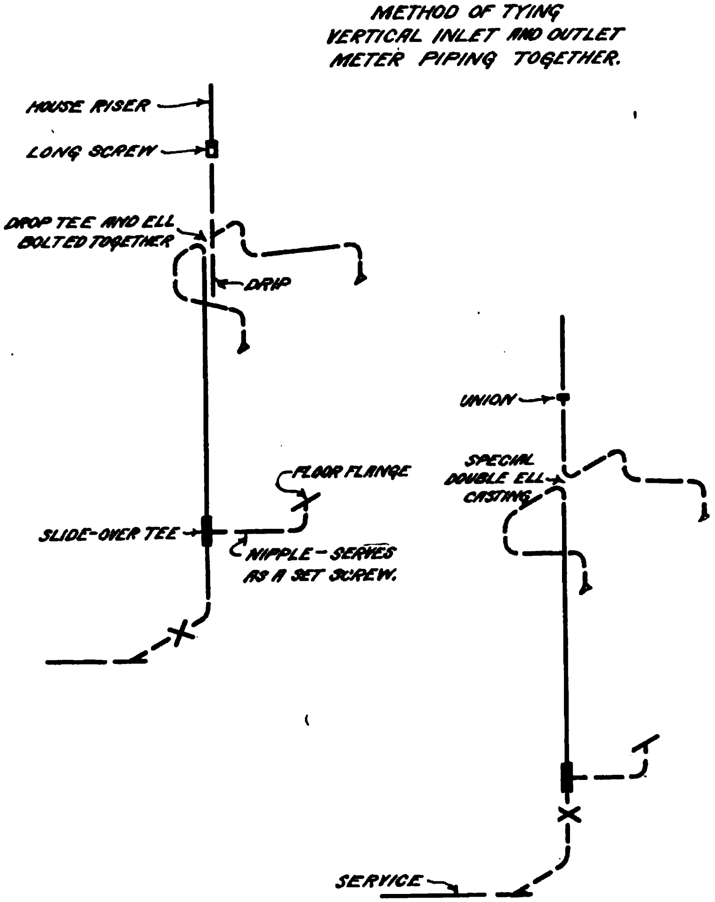
DES MOINES PRACTICE.

The method employed, whereby the inlet and outlet pipes are secured together in a vertical line extending back of the meter, offers several advantages. Simple measurements taken between the head of the service and the bottom of the house riser, will answer as a sketch to enable the connection to be made up in a fitting shop ready for installation upon delivery to the premises.

The bolting together of the drop tee and the drop ell by means of stove bolts, as indicated in one of the following sketches, does not afford as strong, or as rigid a means of tying the inlet and outlet piping together, as does the double ell casting indicated in the same sketch. The first method, however, provides a means of placing a drip on the bottom of the vertical rise to the house piping, although, in practice, the bottom of the house riser is seldom in a position where this may be done. The special two ell casting connection seems to offer advantages over the bolted drop ell and tee connection, all things considered.

The sliding shelf made entirely of ordinary shop fittings and a pipe nipple, comes nearer to the requirements of a perfect meter shelf than does any other type of shelf used at present, with the exception of the hanger type of shelf, consisting of a narrow board clamped under the meter by means of wing nuts threaded on the lower ends of wire hangers suspended from the inlet and outlet meter connections directly above the meter.

A smaller meter cock could be used if it were located on the horizontal arm directly above the meter, rather than below the meter as shown in the sketches.

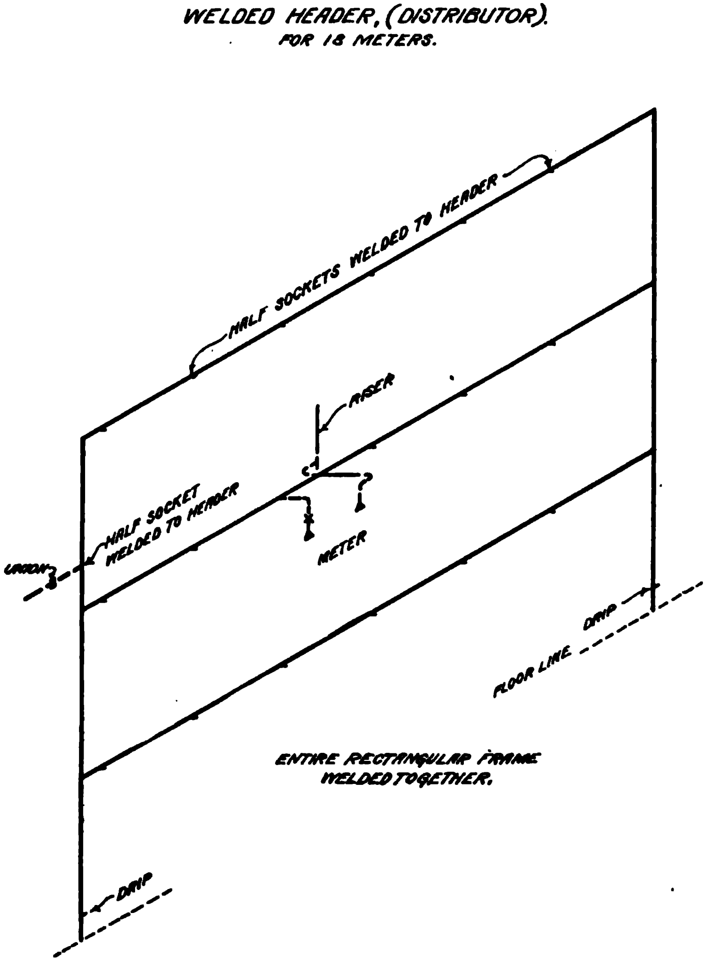


Extra lengths of pipe, equal to twice the width of the meter or more, will be required when the inlet and outlet connections are tied together back of the meter as shown. This, however, is of minor importance in view of the advantages offered by tying together the long sections of the inlet and outlet piping. With properly designed tie-in connections of the bar, or rod type, the use of excessive pipe probably could be avoided.

One possible objection to this method of setting is that the meter is further from the cellar wall than is ordinarily necessary.

PACIFIC GAS & ELECTRIC CO. "WELDED HEADER" (DISTRIBUTOR).

The welded header, shown in the sketch, probably can be


WELDED HEADER, (DISTRIBUTOR).
FOR 18 METERS.
HALF SOCKETS WELDED TO HEADER
RISER
HALF SOCKET WELDED TO HEADER
UNION
METER
DRIP
FLOOR LINE
ENTIRE RECTANGULAR FRAME WELDED TOGETHER.
DRIP

constructed to advantage under certain special conditions, but for ordinary meter setting, meter connections made up from stock fittings, nipples and cut lengths of pipe are preferable.

When the header is required to pass large volumes of gas, necessitating large pipe, or when the meter connections consist of large diameter pipe, the welding process, no doubt, offers advantages over the use of threaded pipe and fittings, provided experienced men and the necessary equipment for this work are available at all times.

Iron Inlet and Outlet Connections and Coupled Inlet and Outlet Connections, Adjustable.

The use of lead outlet meter connections in conjunction with iron inlet connections appears to be going out of favor. For sizes larger than 10 light, no attempt should be made to use other than all iron connections under any conditions.

The lead outlet connection affords greater ease in the connection of the meter, by other than expert fitters, than is permitted by the use of all iron connections. Probably the meters are subjected to fewer strains at the hands of inexperienced fitters, when lead outlet connections are installed, than would be the case if the meter outlet connections were made up of iron pipe and fittings. Doubtlessly, some time is saved and better facing at the meter outlet union joints is afforded through the use of the lead outlet connections. The saving in time, however, is offset by the cost of the lead outlet connections in excess of the cost of all iron outlet connections.

The lead outlet connection affords the maximum flexibility in providing for variable widths of meters and for the facing of the meter screws that are out of the horizontal plane. This very feature, however, renders the lead outlet connection objectionable for use in conjunction with the fairly rigid inlet connection. Meters connected in this manner will tend to drop down on the outlet side, due to the weight of the meters, or to vibration, or other strains to which the meters may be subjected while in service. The lead outlet connections in these cases will conform to the acquired position of the meters, while the iron inlet connections, even when the required number of swing joints have been provided and properly made up, will not give as readily; consequently the weight of the meters, together with the extra load, or strain thrown on the meters in any way, will, to a very large extent, be carried by the sweated joints where the inlet meter screws are inserted in the meter columns. This weight, or strain, does not act as a straight pull on the sweated joints, but as a leverage tending to tear the inlet screws out of the columns and to tear the inlet columns away from the sides of the meters. If meter shelves were placed to support the meters and thus prevent any change in their original positions, the above stated conditions would be avoided. Due to the difficulty experienced in the placing of meter shelves in a secure and satisfactory manner, however, and to the fact that a suitable adjustable meter shelf has not been obtainable, there is no assurance that the meter shelves, placed with the idea that they will support the meters, will perform their function.

The use of all-lead connections affords a better means of connecting meters than does the use of lead outlet and iron inlet connections in combination. The use of all-iron connections is to be preferred to all-lead, or lead and iron in combination, for the reason that they are cheaper, more permanent, less liable to sag, or to be injured, present a much better appearance, and will be productive of fewer meter union washer joint leaks and fewer strained screws and column seams. With the use of all-iron meter connections, in which the proper number of swing joints have been provided, meters may be changed and the meter union joints faced up with as much ease as is the case when all lead, or lead and iron connections are employed.

The use of lead connections necessitates the store room carrying a stock of the several sizes of such connections. No such stock would be necessary if the meter connections were made up of pipe, stock fittings and nipples, although a somewhat larger stock of these cheaper fittings necessarily would have to be carried.

With the use of lead connections, there is danger of the lead pipe kinking, causing complaints of insufficient supply of gas, or of being cut, damaged, flattened, or stolen, while in position, necessitating visits to the consumers' premises and renewal of connections and the necessity for removing the connections when the meters are removed and the gas shut-off in order to prevent theft of the connections.

In present day practice there seems to be no real need for lead connections, except for the purpose of replacing damaged, defective or stolen ones at locations where they had been installed at some previous time, or in situations where it is difficult to obtain, or to train men to the point where they are competent to connect meters with all iron connections.

The practice of tying together the iron inlet and outlet piping at a point close to the meter has met with the approval of many gas companies within recent years. The method of running the vertical inlet and outlet piping so as to form a continuous straight line directly back of the meter, using a special fitting, or bolting fittings together at the junction of the two lines as shown in one of the accompanying sketches, constitutes the cheapest but probably not the best means of accomplishing the desired purpose.

Solid one-piece tie-in connections have been used for the purpose of tying together the horizontal inlet and outlet arms of the meter connections directly over the meter, using offset swivels to obtain the variable distance between meter screws. This arrangement affords the strongest possible tie-in, but does not enable the swivel to be faced up with the meter screws when the faces of the screws are not in the same plane.

It is obvious that a satisfactory tie-in should be so designed as to enable the inlet and outlet connections to be tied securely together as close to the meter swivels as is possible, in order to relieve the meter screws and meter union joints of all strains caused by improper fitting up of the meter connections, or by subsequent strains to which they may be subjected. In addition the tie-in connection should, in some way, provide for variable distances between the meter screws and for the facing up of the shoulders on the meter swivels with the faces of the meter screws which, in practice, are seldom in the same plane. The necessity for proper facing is obvious; swivels and meter screws that do not face up normally, will be jacked together in the making up of the union washer joints, and the meter screws will be subjected to severe strains, tending to tear them away from the meter columns.

A two-piece tie-in connection, possessing all of these desired features has been developed within the past few years. The tie-in in question comprises an inlet and an outlet member. Each member is tapped for a meter swivel and for a piping connection and slotted so as to enable the two members to be bolted together. The construction enables three distinct adjustments of the tie-in connection to be made as follows: for variable widths between meter screws; for facing up with meter screws that are inclined toward the inlet or outlet side of the meter and for facing up with screws that are inclined toward the front or back of the meter, or at any intermediate angles.

In adjusting this connection, the bolts holding the two members are loosened, the swivels screwed tightly in each member, and the union joint made up hand tight on the screws of the meter to be set. The two members are then bolted together in the position they have assumed, the union joints are then broken and the tie-in connection placed on the inlet piping and the outlet piping connection made between the tie-in connection and the bottom of the house riser.

The construction of this connection is such that there is no tendency to distort the position of the members in the act of bolting them together. This is demonstrated by the fact that the caps on the union washer joints, which were made up hand tight before bolting the members together, can easily be unscrewed by hand after the members have been bolted together and, further, by the fact that the shoulders of the tail pieces will be found to be faced up with the meter screws, no matter how badly the screws may be out of their normal positions, and still fit for service.

Other two-piece meter tie-in connections have been placed on the market but they have afforded but one movement and, in consequence, have failed to meet the requirements of a satisfactory connection.

An important feature of the connection covered in the above is the means provided for supporting the meter directly from the connections. Eyes are cast in each member and wire hangers and a thin, narrow rough board are furnished. The wire hangers are suspended from the eyes in the castings and hang alongside the inlet and the outlet columns. The bottom portion of each hanger is threaded and provided with a thumb nut and washer. The narrow board is slotted at each end to enable the wire hangers to be entered in the slots and the board clamped, by means of the thumb nuts, tightly up against the bottom of the meter directly beneath the meter partition. This method of supporting the meter answers all requirements and, as far as we are able to discover, is the only method which affords perfect support to the meter.

An investigation made by a large gas company a few years ago, showed that about 21 per cent. of the 1,800 meters inspected were not supported by the meter shelves. Of the meters thus found without support, 14 per cent. had wooden brackets in position beneath the meters, 48 per cent. had shelves consisting of a board from which two sheet iron wings projected, 31 per cent. had the Spangenberg two-piece adjustable shelf and 7 per cent. had no shelf at all.

An investigation of the new meter work done by the same company during the year 1915, showed that about 4 per cent. of the meters set, or changed, were not supported by the meter shelves, the work of the meter setters being inspected within four days after completion. About 10 per cent. of all the work done by the meter setters was found to be defective in some respects, about 37 per cent. of the defects being due to improper placing of meter shelves, all of which were of the Spangenberg adjustable type.

To set meters with the two-piece tie-in connection, covered in the above, costs more than it does to use straight iron, or lead connections, but for the 3 and 5-light sizes, the additional cost is not excessive and, in a few years, it will be wiped out in the saving effected in meter complaint and meter change work. Owing to the excess cost of this type of connection, it is not deemed advisable to use it on meter sets above the 5-light size.

Several attempts have been made to include the meter cock as part of the iron tie-in connections. This is not advisable, however, owing to the expense that is incurred, due to the number of such connections which, for one cause or another, need to be scrapped, necessitating the scrapping of a cock in good condition in most cases.

Investigation of 1,000 meters set on this type of connection, in comparison with a like number set on all-iron connections, for periods of about one year in each case, showed that the leaks at the meter union washer joints, at the meter screw sweated joints and at the meter column seams on the meters set on the tie-in connection were about 40 per cent. of the leaks discovered on the meters set on all-iron connections in the usual manner. The following table shows the location of the leaks discovered:

Location of leaks that could be attributed to kind of meter connection used	1,000 two-piece tie-in connections	1,000 ordinary iron connections
Inlet union joint	18	50
Outlet union joint	1	10
Inlet screw	5	26
Outlet screw	2	5
Inlet column	3	9
Outlet column	1	4
Tie-in—casting	7	—
Tie-in—casting	4	—
Total leaks	41	104
Leaks at meter cocks	0	3
Leaks at bottom of meter	11	20

Care should be exercised to see that the meter connections are not left unsupported, as there is no more certain way of causing washer joint, meter screw and column seam leaks than to leave the connections and piping in a condition where they will tend to sag, or fall out of position and throw their weight and strains on the meters. Wire hooks, or galvanized wire should be used for supported connections from overhead, and pipe hooks for securing to vertical walls.

The question of the proper kind of meter union washers to use should be given careful consideration. Experience has shown that the best results are obtained from the use of selected, close grain, first quality leather washers. These washers should be of uniform thickness throughout, but all washers need not be of the same thickness. Sufficient thickness should be obtained to provide ample cushion to keep the metal faces from coming in contact with one another when they do not face up exactly true. Thin lead washers have been tried out on an extensive scale, but were found unsatisfactory in every respect. A rubber composition washer, known as "Ebonite," is being used extensively in Philadelphia and promises to give very satisfactory results.

The work of the meter setters in many situations is not subject to inspection; competent fitters are not employed on this class of work; proper drawings, and details explaining the method of setting meters desired by the company are not furnished to the meter setters, and proper schedules are not prepared showing the sizes of meters to be set and the sizes of meter connections to be installed. Satisfactory results cannot be obtained unless all these details are looked after and the fitters properly instructed and their work checked up at regular or at irregular periods. Any outlay made along these lines will prove a paying investment for even the small gas companies, inasmuch as the reduced number of leaks and the meter complaint work resulting, the reduction in the repairs required, and the fewer visits of gas company employees to the consumers' premises, will surely bring down the operating costs, and tend to keep the odor of illuminating gas from the nose of the too sensitive public.

Owing to the necessity of having this report in your hands by the 10th of September, a certain amount of data which has been received is not included on account of lack of time. Moreover, some of the large gas companies have not been heard from.

There are other matters pertaining to the subject of meter connections which it would seem should be taken up and carried on by next year's committee.

W. K. Harrington, *Chairman,*
S. K. Campbell,
W. A. Castor,
D. E. Keppelmann,
C. C. Schiller,
F. C. Shepard.

Mr. Walton Forstall (Philadelphia): (Written discussion communicated.) The standardization of meter connections is, of course, nowhere so important as that of housepiping, but as there is undoubtedly one best way of making each type of meter connection, there is a good deal to be gained by bringing this subject up for discussion and determination of best practice. It will be noted that what the Committee is proposing is not to have the Institute go on record as saying that iron connections are better than lead, or coupled connections better than the ordinary type, but that each individual engineer having decided on the type his conditions seem to demand, the Institute then tells him the best way of installing this type.

The President: The next report is that of the Committee on Cast Iron Pipe Joints, of which committee Mr. G. I. Vincent is Chairman. We will call on Mr. Vincent to present his paper.

Mr. G. I. Vincent (Des Moines): I think it would be well to have this report read by title, Mr. President. I would like to say a word about the work of the Committee. Most of it has been in collecting data. You can imagine our difficulties when I tell you that we have received information from two or more very similar sources of flatly contradictory character. If a new Committee is appointed, and you can find out the mystery of the thing, they can probably save the gas industry a gratifying amount in future installation of gas mains.

REPORT OF THE COMMITTEE ON CAST IRON PIPE JOINTS.

FOREWORD.

The following report is submitted by the Committee on Cast Iron Pipe Joints with the express understanding that no portion of it is necessarily final. The object in allowing the publication of the report in this form is to endeavor to secure the most extended criticism, the necessity for which is made clear in the body of the report. The members of the Committee are not in entire agreement upon all of the suggestions made in the report.

INTRODUCTION.

The fact that cast iron has an indefinite life under ground under normal conditions has led to its use for carrying gas and water. The disadvantages of cast iron for gas work have been its fragility and the difficulty in making positive joints.

It may be expected, however, that cast iron will continue to be used until an alloy of steel is developed which will give a certain life equal to cast iron at no increased cost.

The subject of proper joints to use for cast iron has been the cause of a great deal of experiment, the data of which has never been presented. It has also been discussed frequently in technical sessions and in papers without any definite conclusions.

At present, engineers are using various kinds of joints, largely depending on their own opinion or the opinions of their subordinates.

On the belief that it would be possible to standardize practice, your Committee on Cast Iron Pipe Joints was appointed.

THEORY OF THE JOINT.

For many years the pipe joints were made of lead backed with some form of packing, usually tarred or untarred jute. The lead was cast in place and subsequently caulked.

About 25 years ago the cement joint was introduced and came into use extensively, but as far as your Committee has been able to learn there was no scientific theoretical reason for adopting the cement joint. It was tried, found satisfactory and durable, and gradually came into more frequent use until at the present time it is being used for small mains under normal conditions by nearly every gas company in the country.

The use of cement joints was extended to larger mains with apparent satisfaction. Later developments, however, have brought up strongly the question of the advisability of cement joints for large main joints. At the present time opinion is divided as will be discussed later in this report.

Cast iron main joints may be divided into two classes. First, the rigid joint, in which no possible movement could take place at the joint without leakage. Second, the flexible joint, in which slight movements may take place without leakage. To the first of these classes belongs the cement joint, welded joint, bolted flange joint and the one or more forms of special bolted iron to iron joints. To the second belongs lead joints, lead wool joints, combination lead and cement joints, joints with special impregnated packing and all the various types of joints made up of special clamps with elastic gaskets.

For a rigid joint to be successful, the change in temperature of the main underground should not exceed an amount which will produce stresses in the pipe greater than the strength of the joint. It is not difficult to arrive at changes in underground temperature, due to seasonal changes in temperature, and from this calculation the probable stress set up in the pipe by such change. In the calculations made by your Committee the modulus of elasticity for cast iron was taken at 15,000,000, the coefficient of expansion 0.00000556 and the ultimate tensile strength of cast iron 20,000.

A bar of cast iron rigidly held at both ends is stressed to its ultimate tensile strength by a change of temperature of about 240 degrees. The underground changes in temperature may be expected never to exceed 50 degrees. Therefore, it may be said that cast iron pipe has a safety factor of approximately 5 under these conditions and any joint which will be and remains more than 20 per cent. as strong as the pipe will be theoretically satisfactory.

There is no experimental data sufficiently elaborate to specifically give the strength per square inch by contact between the cement and iron in a cement joint, but even in the absence of experimental data we have sufficient data from practical experience to draw fairly safe conclusions.

Cement joints in small mains 4 and 6 inches have been in use in a number of locations throughout the country with entire satisfaction for over 20 years. This would seem to be sufficiently long to make certain their dependability for small mains.

For large mains, the cement joint has not proved entirely satisfactory. Theoretically this is not unexpected. There seems to be no logical reason for making a rigid joint of a given strength and not increasing that strength when making the similar joint in large mains where it is quite obvious that the stresses will be increased. The point of the matter is that if satisfactory 4-inch cement joints in standard A. G. I. bells are properly designed for strength, then, as the strength depends on the area of the bond between the cement and iron, it is obvious that no joint larger than the 4-inch is strong enough. Of course, there is no justification in assuming that 4 inches is the standard or that it is too strong and, therefore, the larger joints are strong enough. But as stated before in this discussion, we have had the practical experience of a long life in 4-inch cement joints.

In all the other types of rigid joints the large first cost has inhibited their extensive use. There is no reason to believe, however, that a rigid joint in a cast iron main of any size would not be satisfactory, and if such a joint can be designed at practical cost, there would seem to be no reason for not adopting it.

The lead joint has been used for many years and has usually resulted in small leakages at the joint sooner or later. Based on the fact that there is probably a very slight movement taking place at each joint, we would expect this result to follow. The lead wool joint is an advance in art by the substitution of prepared lead wool for cast lead. It is advanced only in the fact that the complete compression of the lead ring can be assured which of course is only true if the packing is compressed sufficiently hard to form a rigid backing for the lead. On this theory the combination joint of packing cement and lead has come into use extensively within the last two years. The theory of this joint is that the rigid cement ring effectually maintains the alignment and provides a solid backing against which to caulk the lead wool. It is not maintained by its advocates that this joint is rigid. It is thought that the same slight movements probably take place, but because of the method of making which insures a more efficient joint, these movements will be so slight as to postpone leakage for an indefinite time.

Sufficient time has not elapsed since these combination joints have been used extensively to determine whether they are going to be permanently satisfactory or not. The longest time in which combination joints are known to have been used is about nine years in large mains with entire satisfaction. These were combination cast lead and cement joints in a 20 inch line.

Another type of flexible joint consists of a packing impregnated with some material insoluble in gas, the joint being packed solidly with this material leaving room in front for a ring of lead or cement to act as a gland. The theory of this joint is that the packing acts as the packing in a stuffing box, allowing the slight movements to take place but remaining permanently tight. This theory seems to be sound, but it must be borne in mind that the packing is not placed between machined surfaces, but simply between the rough castings. Further, it is well known that expansion joints which are carefully made of machined fittings and carefully packed leak at intervals and must be taken up. It is not urged that this is a fair analogy, but there does seem to be some similarity. In this type of joint also sufficient time has not elapsed to prove them effective.

Of the various types of clamped joints on the market a number have proved satisfactory in so far as the design of the clamp was concerned, the failures being confined to the rubber gasket which was used exclusively until the last two years. These rubber gaskets had proved satisfactory through long service for natural gas. They have failed in a large number of cases in comparatively short service with artificial gas. Whether the substitution of the soft core fabric gaskets will remedy the trouble cannot be predicted. Theoretically these joints will eventually leak for the same reason that we may expect any other so-called flexible type joint to leak. The elasticity of the material will probably disappear, or the jointing material will be abraded sufficiently to allow small leaks.

CURRENT PRACTICE.

When starting upon its work, your Committee was familiar in a general way with the current practice of joint making, but in order to ascertain as far as possible the practice of the representative plants in the country, a brief series of questions was sent to seventy of the larger companies. A copy of these questions is attached to this report. Several interesting conclusions have been drawn from the fifty-eight answers received. A brief summary expressed in percentages follows:

	Low pressure up to 10″ water	Medium pressure 10″ water up to 5 lb. gaug
Use standard bell and spigot pipe......	94	94
Use extra depth of bell...............	6	6
Cement joints in small mains..........	62	53
Cast lead joints in small mains........	29	30
Lead wool joints in small mains.......	9	17
Cement joints in large mains..........	29	25
Cast lead joints in large mains........	49	45

	Low pressure up to 10" water	Medium pressure 10" water up to 5 lb. gauge
Lead wool joints in large mains.......	15	19
Combination cement and lead.........	7	11
	(Inches)	(Inches)
Size where line drawn between large and small mains, average.........	11.5	10.8
Small joints satisfactory—per cent. of total	98	97
Small lead joints unsatisfactory—per cent. of used	12	15
Small cement joints unsatisfactory—per cent. of used	0	0
Large joints satisfactory—per cent. of total	73	72
Large cement joints unsatisfactory—per cent. of used	53	67
Large lead joints unsatisfactory—per cent. of used	10	19
Large lead wool joints unsatisfactory—per cent. of used.................	0	14
Large combination joints unsatisfactory—per cent. of used...........	0	0
Companies having tried some special form of pipe	29	*
Special joints satisfactory	35	0
Special joints unsatisfactory	65	0

* Not enough reported to give statistics.

Sixty-five per cent. of the companies reporting, used cast iron for medium pressure. Only 7 per cent. used cast iron for high pressure, or not enough to present data until further development by correspondence or investigation, for which there has not been time.

Care should be taken in drawing any final conclusions from the summary, but your committee believes that there are certain strong tendencies in current practice which are clearly shown, and which may be taken to indicate in a general way what the distribution engineers of the larger companies are doing.

A table of this kind prepared say three years ago would not have shown any combination joints being used. The fact that there are no reports of failures of the combination joints is significant, but should not be taken as conclusive as yet, as sufficient time has not elapsed to determine their ultimate value.

The high percentage of large cement joints reported unsatisfactory is also significant. This does not mean of course that there was this percentage of failures. In fact there is nothing in the reports to indicate any total failures. The conditions are probably that the cement joints in large mains are not satisfactory to the responsible engineers, and a strong effort is being made to improve joints or substitute a more satisfactory type.

It will be noted that not by any means all the companies are using cement joints in small mains. The reasons for using lead wool in some locations are known to your Committee but why any engineers are still using cast lead in small main joints under normal conditions is interesting, and should be developed further by correspondence.

A study of the summary indicates, however, that the large majority of engineers are thoroughly satisfied with the cement joint for small mains and your Committee does not hesitate to recommend the cement joint in standard A. G. I. bells for small mains, but does not feel that there is sufficient data at hand at this time to specifically set the limit of size over which the cement joints in standard bells would not be satisfactory. There has been prepared, therefore, a specification for cement joints which embodies what your Committee believes to be the best practice.

SPECIFICATIONS FOR CEMENT JOINTS.

1. The efficiency of a cement joint depends on filling the clean joint with the maximum quantity of the proper quality of cement properly mixed.

2. In the A. G. I. standard depth bells cement joints should be made only up to and including 8-inch mains.

3. In 10 inch and over cement joints should preferably be

made in deeper bells, the depth of which should be not less than that given in the following tables:

Inches	Inches
10 - 5	20 - 6¾
12 - 5½	24 - 7½
16 - 6¼	30 - 8½

4. Four, 6, 8 and 10-inch mains may be laid on the ditch bottom; 12-inch and over on blocking.

5. The spigots and bells must be clean and free from all loose material. Dirt and scale must be removed with wire brushes and scrapers. Tar or any substance of an oily nature may be removed with gasoline but must be subsequently scrubbed with soap and water and rinsed thoroughly with clean water. Clean bare iron is absolutely necessary.

6. The ditch must be levelled to a true bottom and the bell holes dug. The pipe must be entered, pushed home and lined up without entering any packing whatever in the joint, thus departing from the old practice, in small mains, of using the back packing to lift and enter the spigot into the bell and then driving up the back packing to space the joint. With a properly bottomed ditch the joints will be very nearly spaced when the pipe are entered and lined up.

7. In 4, 6, 8 and 10-inch mains the joints must be spaced with wedges. See "A" Fig. 1.

8. Tap in lightly two of the wedges about at the two lower thirds of the circumference of the pipe and the third wedge at the top. Sliding the fore-fingers around the joint is a simple and accurate method of determining if the joint is properly spaced. Sufficient wedges should be provided to allow laying as many pipe as desired before joint making.

9. Cover and tamp the pipe firmly into place between the bell holes. The tamped earth covering has two important functions—1. It holds the pipe firmly in place for the joint making. 2. It maintains the pipe at a much more uniform temperature during the progress of joint making and subsequently, than would be possible if exposed to the atmosphere.

10. Use untarred jute packing dry and free from oil in the bales.

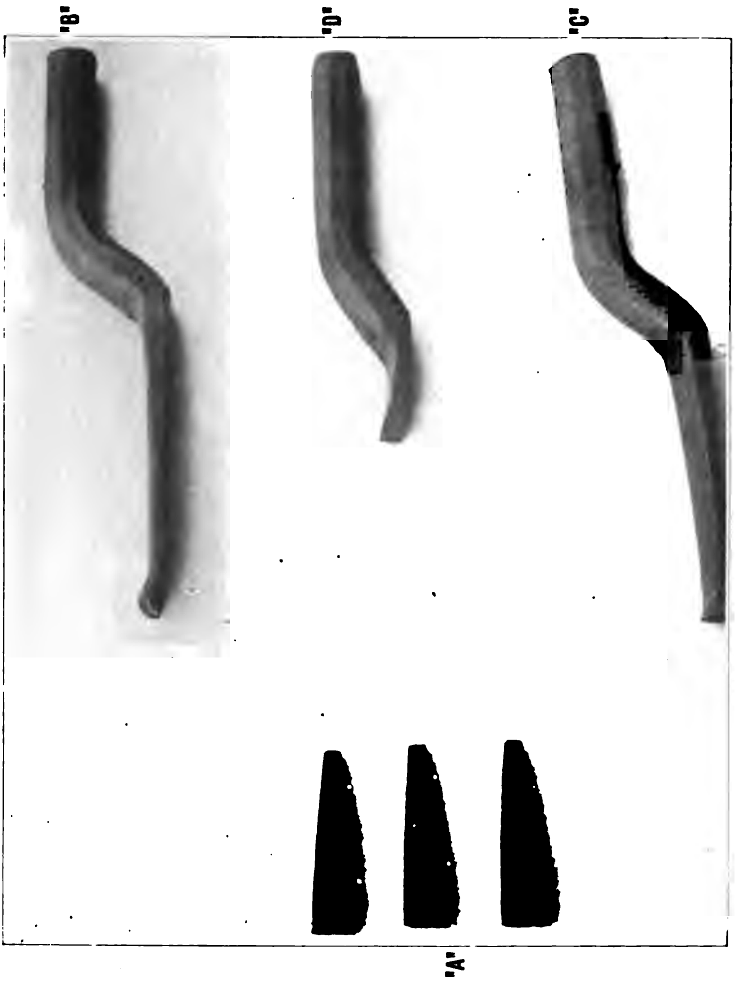


FIG. 1.—CAULKING TOOLS AND WEDGES.

11. The back packing must be wet with clean water and thoroughly wrung out by twisting into a tight rope. This wet rope of packing must have a uniform diameter of from $^7/_{16}$ to $\frac{1}{2}$ inch. Do not grout the packing. This rope of packing

should be of such length as to reach one around the spigot and lap 1 inch.

12. Remove the wedges and enter the packing. If the spigot has a bead, use the yarning iron shown at "B" Fig. 1, driving the yarn into the wedge shape recess formed by the bead on the spigot and the filet on the back of the bell, as shown in Fig. 2. Use a four pound caulking hammer for all cement joint work. If the spigot is cut, use the yarning iron shown at "C" Fig. 1, which will compress the yarn as shown at Fig. 3.

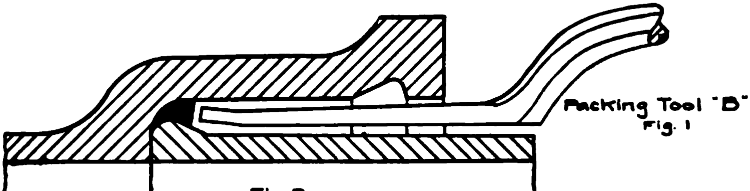


Fig. 2

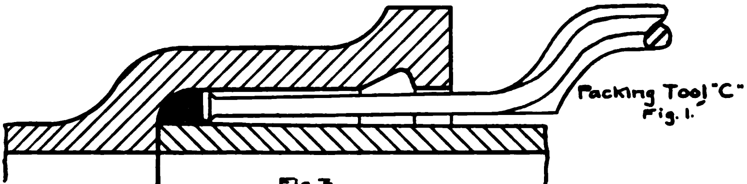


Fig. 3.

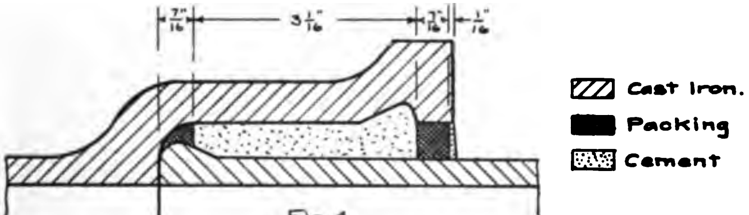


Fig. 4

13. The cement should be a high class medium setting American Portland cement and must be in perfect condition, and must all be passed through a No. 50 screen before mixing. Mix thoroughly by hand to a consistency of a stiff putty in such quantity that all will be used within 15 minutes after

mixing. Discard any mixed longer than this time. Mix in the shade.

14. With a small trowel fill the joint with cement flush with the face, then use a ½ inch cotton rope slightly longer than the circumference of the pipe and drive in the cement with the caulking tool shown at "D" Fig. 1. Withdraw the rope and fill the joint flush with the face with cement. Wet and twist a piece of yarn that will be of uniform diameter of from $^9/_{16}$ to ⅝ inch when twisted tightly. Drive this yarn into the bell with wide face caulking tool "D."

15. The making of the joint must proceed continuously, there being no lapse of time between the successive operations.

16. Point the face of the joint with cement so that it is smooth and flush with the face of the bell. Fig. 4 shows a section of the finished joint.

17. Do not make joints until the pipe has assumed approximately the temperature of the ground. If the sun shines in the ditch, shield the pipe exposed in the bell holes from the direct rays of the sun. This becomes increasingly important as the size of the pipe increases.

18. Test the joints with soap and water under gas pressure. If the mains are intended to carry any higher than the usual low gas pressures, test them with air pressure and soap suds at twice the pressure that the system is laid to carry. When testing with air at high pressures, the test should not be applied until the joints have been made 24 hours or longer, and greatest care must be used to avoid temperature changes in the pipe while waiting for the test.

19. The above method should be followed in the 4, 6, 8 and 10-inch mains. For mains 12 inches and over (mains 10 inches and over must have special depth bells for cement joints) the same procedure as for mains 10 inches and under should be followed with the following exceptions and additions.

20. After bottoming the ditch to a true line, wood blocks are set in front of and behind each bell and carefully and solidly embedded so that the top surface is the true plane of

the bottom of the pipe. After laying the pipe and entering, the joints are spaced by wooden wedges on the blocking.

21. With bells 6 inches and over in depth, after driving the cement in with the cotton rope and withdrawing the rope, the joint must be again filled with cement and again driven in with the rope, then filled again with cement and the front packing entered.

22. For mains 20 inches and over the rope of back packing must be from $^9/_{16}$ to $5/8$ inch in diameter and the front packing from $5/8$ to $3/4$ inch in diameter.

23. Increasing care must be used to maintain uniform temperature of the pipe as the size increases. Especial precautions must be taken to assure that there is practically no difference in temperatures between the top and bottom of the large pipe.

COMMENTS ON SPECIFICATIONS.

This specification has already been submitted to a number of Distribution Engineers and your Committee has incorporated the criticisms that have been received. Also where the specification departs from current practice, the reasons for the practice selected will be given.

The numbers refer to the paragraphs of the specifications.

1. This is based on the assumption that the cement joint is a rigid joint and that its strength depends on securing a most intimate contact between the cement and iron of the bell and spigot and filling the lead ring with cement. If the cement joint is not a rigid joint, which is incredible, then the amount of cement would still be an important factor because it is obvious that the larger the area of contact, the less likelihood there would be that the leakage would be serious under low pressures.

2 and 3. Your Committee has purposely not made these paragraphs imperative because of the fact that in a few instances cement joints in large mains, as large as 20-inch and over, have been satisfactory in standard bells. There is, therefore, no

justification for condemning the practice, but in the face of the evidence of the dissatisfaction that has been reported, your Committee does not fell justified in recommending that the cement joint be made in the large mains in standard bells.

4. The large majority of engineers do not use blocking when laying mains in undisturbed ground. Either small mains are laid directly on the ditch bottom, or where abnormal conditions exist a special design is made. For mains 12 inches and over the blocking is used for joint spacing as described under paragraph 18. The following schedule of blocking and wedges is suggested:

	Size of blocking			Size distance pieces			Size of wedges		
Size mains In.	Thickness In.	Width In.	Length In.	Thickness In.	Width In.	Length In.	Thickness In.	Width In.	Length In.
12	3	12	18	1	12	12	2	5	8
16–20	3	12	24	1	12	24	3	5	12
24–30	4	12	30	1	12	24	3	5	12

5. It would be possible to elaborate this paragraph but your Committee believes it is sufficiently complete, particularly with the final sentence, that clean bare iron is absolutely necessary.

6. This is the first radical departure from the current practice and was purposely adopted because the fundamental idea of this specification is expressed in the first paragraph, and in order to insure having the maximum quantity of cement in the joint it is necessary to insure having the minimum quantity of packing necessary to insure a satisfactory joint. With the current practice of lifting the spigot by the back packing there is certainly a tendency toward having this packing unnecessarily thick and often unnecessarily long.

7 and 8. The carrying of the spigot on wedges tapped into the joint is not a new idea, having been used heretofore in making large main joints by a number of engineers. It is introduced here for the reasons given under 6. The additional labor adds very little to the cost of the joints. This was determined by actual experiment. It is one of the points selected by your committee to insure better joint making. A number of comments have been made on it to the general ef-

fect that the operator has not found the practice necessary. This is not denied by your committee, but the use of the wedges in small mains has been the practice in several locations and has undoubtedly proved advantageous and will certainly be an improvement where the joints are undertaken by more or less inexperienced operators.

9. This paragraph is self-explanatory but a brief discussion may be made here in regard to the effect of temperatures in laying mains with cement joints. Small mains have been laid with cement joints when the atmosphere was below freezing with entire satisfaction. It is obviously necessary under these conditions to take additional protective measures, but your committee feels that this is a matter of common sense and judgment on the part of the operator and needs no specific recommendation in discussing the subject of cement joint making.

10. In ordering jute packing the specification should state, "Dry and free from oil," but as a matter of fact jute packing supplied by the trade will never be entirely free from oil or tar. A very small amount is not detrimental.

11. Here is a second departure from current practice as the majority of engineers do not wet the packing. It has been found by experiment that wetting the packing has several advantages. In twisting it into a rope it can be made tighter and is comparatively free from projecting strings. In other words it makes a smooth tight rope as compared with a loose fuzzy rope when dry packing is used. It will pack more solidly into the bell and when finished will have a more uniform front surface than dry packing. This was determined by actually driving the back packing into split bells which were subsequently taken apart and examined. It is also highly probable that a very dry packing does actually inhibit the setting of the cement in immediate contact with it. This was also tried out in a split bell and the cement in contact with dry packing, after one week's setting, was, while hard, more crumbly and friable than where the wet packing was used.

12. The question as to whether special tools are necessary for cement joints has been commented upon by all who have criticised the specification. One comment suggested that the design of tools offered would probably break in practice. This is simply a question of properly making the tools. Most of the other comments were to the effect that they had not found such tools necessary and exactly the same reply can be made by your Committee as in the discussion of paragraph 8. The tools suggested will give a more uniform ring of packing than will the usual type of yarning irons. This was proved by actual experiment before the tools were adopted for the specification. One comment on the specification suggested that the committee recommend that cement joints should not be used where the bead is cut off the spigot. In the absence of any specific data as to the strength of the bond between the iron and cement, and further there being no reported experience from practice that these joints would fail in use, your committee does not feel justified in making such a recommendation. This is particularly true as they do not feel that they have at this time any substitute joint to offer.

13. The original specification called for Dykerhoff cement as a first preference. This brand is practically out of the market and further it is questionable whether it is as good as when it was first used for cement joints about ten years ago. Further work of this committee should include the preparation of a specification for cement for cement joints. It will be noted that the cement must be in perfect condition, which was thought to be sufficient qualification rather than to go into details, but the screening is included. This was done purposely as even when cement is apparently carefully stored it will sometimes become a little damp in spots and lumpy. The specification, therefore, provides for screening to insure its being free from such lumps. It is provided that it will all be used within 15 minutes after mixing and this was specified rather than saying, "Mix enough for some given number of joints", which is the usual formula. The weakness of this is obvious.

14. The fact that a trowel was satisfactory to fill joints was

determined by experiments with the split bells, but of course there is no implication that the cement may not be satisfactorily placed in the joint with rubber gloves as is the practice in a number of locations. The trowel was cheaper and more durable. The use of the rope for driving in the first filling of cement is also not a new idea but is offered in this specification as an improvement over the current practice. Experiments show that the width of the cement band would be increased ½ inch by the use of the rope and the refilling, over the usual practice of filling the joint once either with gloves or with the trowel. If a pusher were used there was not so much gain by the use of the rope. This is, however, one of the points that your Committee believes will go further to insure more uniform joint making. If the practice as suggested is followed there would apparently be no question of having the joint filled properly with cement, while we do not believe this would always hold with the usual method of making the joints.

15. This paragraph is self-explanatory.

16. This pointing is done to seal the front yarn and to make a sharp surface to test the joint. This operation can be done better with the trowel than with gloves. The section shown is an average of a number of joints made in the split bells by the methods described. There would seem to be no question that they are an improvement over the sections usually shown.

17. This paragraph was added as your Committee believes the efficiency of the operation will be increased if an approximately uniform temperature is maintained from the time the joint making starts until the pipe is finally covered.

18. This paragraph is included because the majority of engineers believe that joints should be tested. As a matter of fact a very respectable minority do not test their joints in small mains when laid for ordinary gas pressures.

19. This and the following paragraph do not imply that your Committee sepcifically recommends the use of cement joints for large mains. It is believed, however, that there is sufficient evidence to indicate that they can be satisfactorily made in deeper bells and this and the following paragraphs

are, therefore, included. Three reports on the use of deeper bells for cement joints for large mains have been received. One was used in combination with lead joints; *i. e.* several cement joints followed by one lead, and the report was that the cement joints were entirely satisfactory. The second part was on a continuous line of cement joints. The report here was promising but not entirely favorable. The third was from a situation where cement joints in standard bells had been used in all sizes of large mains up to 24 inch with numerous failures. The experimental line had at the time of the report been in use for two years with no sign of failure. This was a line of main with depth of bell as given in this specification and cement joints made up according to the directions.

20. It is not good practice to attempt to space large joints with the yarn when the minimum quantity of yarn is to be used as in cement joints. Therefore, the larger and heavier pipes are spaced with wooden wedges on wooden blocks.

21. This is added as an additional precaution to insure the complete filling of the joint with cement.

22. This is to care for the wider angular ring in the larger joints.

23. This is added as an additional precaution in caring for temperature changes.

Before leaving the subject of cement joints one important advantage should be touched on and that is a line of main laid with cement joints is practically a non-conductor. Data collected from electrolytic surveys indicates a large immunity in gas-main systems laid with cement joints.

The further work of a committtee on this subject should include experimental work to determine an efficient and reliable large joint. There has been a great deal of experimental work done with some interesting results which are not as yet conclusive. Through the courtesy of The United Gas Improvement Company a summary of the data of a series of tests made by Mr. O. B. Evans are given herewith.

The joints were made with 20-inch special bells and tested in a testing machine of 500,000 pounds capacity at the University of Pennsylvania and are subjected to alternate compression and tension. The tests were based on the fact that a 20-inch cast iron main underground subjected to a temperature change of 30° would be stressed 125,000 pounds and would be subjected to alternate compression and tension due to the seasonable changes. In these tests the joints were made up as carefully as possible, the bells being of the standard A. G. I. depth. During the alternate compression and tension stresses placed on the joint air pressure of from 2½ to 4 pounds was kept on the joint and they were tested for leaks by using a trough made of putty around the joint and filling the trough with water. This was a more positive method of testing than with soap suds.

The cement joint, which was made in the usual way and not according to the Committee's specification, as this work was undertaken before the final specification was prepared, failed under a tension strength of 40,000 pounds approximately one-third the safe load. The cast lead joint made with the standard method with yarn and cast lead properly caulked failed after six reversals at about 25,000 pounds. Lead wool joints with 1, 1¼ and 1¾ inches of lead wool caulked with a pneumatic hammer in the usual way remained tight for 50 reversals with a maximum of 80,000 pounds tension and compression with a movement greater than would be experienced by the main underground.

The combination cement and lead wool joint consisting of back yarn, a band of cement which was allowed to set and then lead wool caulked in front proved about the same efficiency as the lead wool and yarn alone.

These experiments were continued with cement, cast lead, lead wool, and combination lead wool and cement with the results that the lead wool or combination cement and lead wool, caulked with a pneumatic hammer was shown to be the most satisfactory under laboratory conditions.

At this time your Committee feels justified in suggesting that in mains 10 inches and over a joint made of a combination of cement and lead wool will probably prove satisfactory. One inch of lead wool gives as high an efficiency as the wider bands in making up these joints. After filling the joint with cement to a point 1¼ inches from the face of the bell the space should be carefully cleaned and after the cement has set not less than 24 hours the lead wool should be caulked in with a pneumatic hammer or with handled caulking tools and 8 pound striking hammers.

The further work of the Pipe Joint Committee should include the proposition of preparing a definite specification for the making of these combination joints. Unfortunately The United Gas Improvement Company's experiments have not as yet taken up the cement joint in deep bells. It is hoped that this work can be done within the next year.

One further interesting experiment which Mr. Evans made was on a joint with impregnated yarn. This joint is made up on the theory of the stuffing box as described earlier in the report. Under the test the joint failed under 18 reversals at 40,000 pounds pressure with an elongation of 0.2 inch. This method of testing was not conclusive, however, because 0.2 of an inch is a much greater amount than a joint would move with the underground range of temperature. Your Committee believes that the only laboratory test that would give any indication of the value of this joint would be to subject the joint to continuous reversals through a range slightly in excess of that which would be expected in underground work.

In line with the so-called stuffing box joint and on the theory that the packing plays a most important part in any type of so called flexible joint as distinguished from the rigid joint, Mr. Evans made a very interesting experiment. He found that with two joints made up as nearly as possible identical that the one with the yarn driven the harder showed the lesser tendency to leak. If this could be shown by laboratory experiment to hold in practice, it would make a most interesting advance in the practice of joint making. The idea is worthy of much further experiment.

CONCLUSION.

It will be apparent upon reading this report that the work is incomplete. This is largely due to the lack of time and the fact that the data is scattered and confusing.

Your Committee respectfully recommends that this report be accepted as a report of progress and that your committee be continued or another committee be appointed to continue the work.

G. I. VINCENT, *Chairman,*
JOHN A. CLARK, JR.
R. A. JAYNE,
G. T. MACBETH.
J. D. VON MAUR,

CAST IRON PIPE JOINTS.

List of Questions Prepared by Committee on Cast Iron Pipe Joints, American Gas Institute.

Following the suggestion made at the 1914 meeting of the American Gas Institute, a Committee on Cast Iron Pipe Joints was appointed.

This committee has now been at work about three months and has collected a great deal of data from various sources.

They have found:—

1. That there is practically no uniformity of practice in the making of cast iron pipe joints in gas mains with the possible exception of the smaller size low pressure mains.

2. Types of joints found to be entirely satisfactory under some conditions fail under others with no apparent reason.

The Committee expects to place before the Institute all the information at hand in some concrete form.

The information which now is largely lacking is in regard to types of joints other than the standard bell and spigot, and we are taking the liberty of asking you to answer the following questions.

We appreciate that this method of gathering information has been used to a great extent during the last few years and that we are taking the chance of making ourselves a nuisance, but in spite of its disadvantages, it seems to be the only method of securing information which cannot fail to be of value to the gas industry.

All the questions refer to cast iron mains only.

LOW PRESSURE CAST IRON MAINS—Carrying up to 10 inches water column pressure.

1. Do you use standard bell and spigot joints?.................
2. What kind of jointing material in small mains?..............
   What kind in large mains?................................
3. Where do you draw the line between large and small?........
4. Have the small joints been satisfactory?.....................
5. If not, why? ....
6. Have the large joints been satisfactory?.....................
7. If not, why? ....
8. Have you used any special type of joint, such as flange, universal joint, etc.? ....
   ....
9. Were they satisfactory? ....
10. If not, why? ....

MEDIUM PRESSURE CAST IRON MAINS—Carrying between 10 inches water column pressure and 5 pounds gauge pressure.

1. Do you use standard bell and spigot joints?.................
2. What kind of jointing material in small mains?..............
   What kind in large mains?................................
3. Where do you draw the line between large and small?........
4. Have the small joints been satisfactory?.....................
5. If not, why? ....
6. Have the large joints been satisfactory?.....................
7. If not, why? ....
8. Have you used any special type of joint, such as flange, universal joint, etc.? ....
   ....
9. Were they satisfactory? ....
10. If not, why? ....

HIGH PRESSURE CAST IRON MAINS—Over 5 pounds gauge pressure.

1. Do you use standard bell and spigot joints?.................
2. What kind of jointing material in small mains?..............
   What kind in large mains?................................
3. Where do you draw the line between large and small?........
4. Have the small joints been satisfactory?.....................

5. If not, why? ....
6. Have the large joints been satisfactory?....................
7. If not, why? ....
8. Have you used any special type of joint, such as flange, universal joint, etc.? ....
   ....
9. Were they satisfactory? ....
10. If not, why? ....
11. What is the highest pressure you have ever used in continuous service in cast iron pipe?..............................
12. What kind of joints were used?...............................
13. Were they satisfactory? ....

MR. O. B. EVANS (Philadelphia): (Written discussion communicated.)—During the summers of 1914 and 1915, a series of experiments was made at the University of Pennsylvania to determine the efficiency of various types of cast iron bell and spigot pipe joints. This report is intended to be a general summary of the ground covered by the detailed reports which already have been made and placed in file.

THEORETICAL CONSIDERATIONS.

Causes of Leaks.—It seems evident that if a joint is once tight and no relative motion of the bell and spigot takes place, the joint will continue to remain tight. In practice, stresses are brought to bear upon the pipe which tend to pull apart the bell and spigot. These stresses may be due to changes in temperature, to settling of the ground, to vibration from traffic, and to other causes. We have assumed, however, that leaky joints are due to stresses brought about by temperature changes in which there is a simple expansion or contraction of the pipe.

Actual experiments show the variation in temperature of a gas main having an average cover on top of the main of 3 feet 5 inches, to be from 79° in July (with an air temperature of 80°) to 37° in February (with an air temperature of 26°), or a total variation of 42°. The maximum difference in temperature between the top and bottom of the main amounts to 3.4°, the average difference being considerably less than this.

If a main could be laid in winter at the lowest temperature to which it would later be subjected and with all the joints home (metal to metal), any rise in temperature would tend to elongate it. Such compressive stresses as were produced would then be transmitted by the metal of the pipe, and the jointing material itself would carry no load. If, on the other hand, the main were laid in summer at the highest temperature to which it would ever be subjected, any temperature stresses subsequently set up would tend to contract the pipe, and the joint would have either to transmit the entire load or else slip.

Large mains should be laid in the early spring when the air temperature is comparatively low; in such cases the temperature of the main when the joints are made will probably be not far from 30° above the lowest temperature which it will later reach, and the tension to which a joint will thereafter be subject will be due to a temperature change of about 30°. Since the temperature of the top of the main is very nearly the same as that of the bottom, bending stresses due to unequal expansion and contraction, probably do not occur.

We have based our experiments, therefore, on the assumption that leakage in street mains is due to an expansion and contraction brought about by this change in temperature, and that if a 20-inch main is subjected to a 30° variation in temperature it will, if held rigid, be stressed 125,000 pounds, and if allowed to move freely, it will vary its length 0.027 inch per 12-foot length. In practice, it is probable that the earth surrounding the main, clamps it sufficiently to reduce materially the load to which the joint is subjected. It is probable also that there is a combination of motion in the joint and stress transmitted by the joint, the sum of the two totaling the effect of the temperature change.

Cement Joints in Small and Large Mains.—The general experience of gas companies has been that cement joints are tight on small size mains, but that they fail upon sizes about 16-inch and above. The reason for this is readily seen. If we assume that the adhesive strength between cement and cast iron amounts to 250 pounds per square inch, that the shearing strength of cement in the lead crease is 2,400 pounds per square inch, that the amount of cement in shear in a bell is the width of the lead crease (¾ inch) times the circumference, that the total depth of the cement in the bell is the depth of bell less 2¼ inches (to allow for the yarn and for the bead), we find that the total strength of a 4-inch joint amounts approximately to 41,000 pounds, and that of a 20-inch joint to 170,000 pounds, a ratio of 1 to 4.1. For a given change in temperature, the stress carried by a 20-inch pipe will be slightly more than eight times that carried by a 4-inch pipe. In other words, the load of a 20-inch pipe is eight times that of the 4-inch pipe, while the strength of the joint, if made of cement, is approximately only four times as great. If the depth of the bell of the 20-inch pipe is increased to, say, 7 inches, the total strength of the joint will be increased to about 215,000 pounds, and the ratio of the strength of the joint of the 4-inch pipe to that of the 20-inch pipe is now as 1 to 5.3, whereas the ratio of the loading as before is as 1 to 8.

The above figures show why a cement joint on a large main should be less satisfactory than on a small main, and why deepening the bell has not overcome this difficulty. This is in line with practice, which seems to indicate that deep bells (6 and 7 inch) are no less liable to leakage than are short bells (4 and 4½ inch).

Requirements of a Satisfactory Joint.—It seems, therefore, that a joint to remain tight must either be sufficiently strong to transmit the load without slipping or else must act as a stuffing box and allow relative motion of the bell and spigot while still maintaining a gas-tight joint. The usual form of rigid joint is the cement joint, and this in practice has failed for large size pipe.

EXPERIMENTAL.

Method of Testing.—On the assumption that leaks in street mains are caused by simple expansion and contraction due to changes in temperature, 20-inch pipe joints were pulled at the University of Pennsylvania.

Two joints were made up, placed in the testing machine and subjected to a continuous air pressure averaging 3.1 pounds per square inch. Since the pipe was vertical, the face of the joint was left slightly below the face of the bell, and the trough thus formed was filled with water. This facilitated the detection of all leaks no matter how minute.

The joints were subjected to alternate tension and compression stresses, increasing in magnitude until the joint either leaked or slipped. If slipping occurred, only enough load was applied on subsequent reversals to move the joint in and out a predetermined amount. One pull and one compression was called a reversal, each reversal corresponding to a definite temperature change.

In the earlier experiments, when one of the joints failed, there was no provision for testing the remaining one; this accounts for the fact that all joints were not tested to failure. In the later work, provision was made to clamp either joint when it failed and continue the test upon the remaining joint.

A summary of the experiments to date is given in the table. This shows the performance up until the time when leakage became permanent. In most cases, the tests were carried beyond this point; such data is given in the detailed reports.

In all cases the leaks developed on the spigot side of the joint and not on the bell side.

DETAILS OF TESTS.

Cement Joints.—The three cement joints tested failed very quickly and under a light load. It should be noted in this connection that a cement joint is very weak when green, and before the main is covered, such a joint may be subjected to considerable variation in temperature, and leaks may be started before the main is under ground.

Cement and Soap Yarn.—This joint was made up with a specially prepared soap yarn in place of the ordinary yarn, this yarn being supposed to act on the order of a stuffing-box packing. The test did not indicate any great superiority over the ordinary cement joint.

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Cast Lead.—In the cast lead joint probably only the face of the lead is caulked against the pipe, and adhesion takes place for a depth of only a fraction of an inch. The yarn itself is not driven up by the caulking of the lead, and the tightness of the joint must, therefore, depend upon the tightness of the lead itself. For this reason, it seems that the cast lead joint is not satisfactory.

Lead Wool.—Some experiments made upon a split sleeve bell indicated that when lead wool is driven up by hand, the lead in the crease is not thoroughly compressed; when driven up with a pneumatic hammer, the compression in the lead crease is much better. Specific gravity tests of lead wool driven up with a large hammer (3-inch stroke, 1,800 strokes per minute, 20 cubic feet of air per minute), and with a small hammer (1½-inch stroke, 2,800 strokes per minute, 12 cubic feet of air per minute), showed that the compression of the lead was as great with the small hammer as with the large.

The joints made up with lead wool alone (no yarn), and the lead groove, compared with a similar joint having no lead groove, indicated a much better efficiency of joint when the lead groove was not present. This corroborates the belief that lead is not well compressed in the groove. If, therefore, the lead wool itself is to be relied upon for making the joint gas-tight, no groove should be used.

Cement and Lead Wool.—On the theory that the tightness of the joint depended on the adhesion of the lead wool to the iron, several joints were made up with cement in place of yarn, the lead wool being driven directly upon the cement after it has been allowed to set over night. In this way the lead wool was caulked against a more rigid backing than that presented by the yarn alone, and the compression of the wool could be more complete. Tests of these joints indicated a marked superiority compared with the same quantity of lead used in conjunction with yarn, in spite of the fact that inspections of such combination lead and cement joints made up in a special split bell, showed that the driving up of the lead against the partially set cement in many cases cracked it. In the actual use of this type of joint on the street, the compression of the lead was so great as to split a number of bells; the practice was, therefore, given up.

Lead Wool and Yarn.—Tests of the small pneumatic hammer compared with hand caulking and with the large pneumatic hammer, showed that the joints driven up with the large hammer and by hand were very much more efficient than the joints driven up with the small hammer. Since earlier experiments seemed to prove that with hand caulking the lead wool is not as well compressed in the groove as with machine caulking, and that the compression of the lead as a whole is as great with the small hammer as with the large hammer, it would seem as though the increased efficiency of the joint when made up with the large hammer or by hand must be due to a better compression of the yarn behind the lead wool.

No leaks appeared at the conclusion of the test upon the joint driven up by hand. Three holes were then drilled through the face of lead into the yarn; one hole leaked one bubble every five seconds, the other two holes being tight. This would seem to indicate that in the case of this particular joint, at any rate, the yarn itself was practically gas-tight, and that one function of the lead had been to compress the yarn, and thereafter to hold it in position.

Attention should be called to the great relative motion between bell and spigot which frequently took place with no leakage.

Lead Wool and Yarn in Alternate Layers.—Upon the theory that the yarn itself makes the joint gas-tight, two joints were made up with alternate layers of yarn and lead wool, the idea being that in this way a more thorough compression of the yarn could be obtained. The two joints so made up tested out very differently; one was exceptionally efficient, the other no more so than the ordinary type containing the same quantity of lead wool. In one joint there was a relative motion of bell and spigot of nearly ¼ inch with no leakage.

Lead Wool and Yarn with Smooth Spigot.—If a joint is to act upon the principle of a stuffing-box, it would seem that the smoother the spigot piece, the less the liability to leakage. On this basis the bead was removed and the end of the spigot turned up smooth in a lathe. Two types of joint were tried (the ordinary type and that having alternate layers of lead wool and yarn), and both proved disappointingly inefficient.

SUMMARY AND CONCLUSIONS.

The series of tests so far completed indicate clearly the superiority of lead wool over the cement or cast lead for joint material.

Lead wool of itself when used in conjunction with the lead groove is of little value; when used without the groove, it is more efficient. If, therefore, the lead wool is to be depended upon for gas tightness, no groove should be used.

A given quantity of lead wool produced a much more efficient joint when used in conjunction with yarn than when used alone. (In both cases the lead wool occupied the same place in the bell in relation to the lead groove.) Since the compression of the lead wool when used alone and backed up by iron must be greater than when backed up by the more or less yielding yarn, it seems evident that the superiority of the lead wool—yarn-joints, must be due to the presence of the yarn.

A given quantity of lead wool when backed up by cement appears to produce a better joint than when backed up by yarn alone. Reasoning as above, that the compression of the lead itself is not the determining factor in producing a tight joint, the difference must be in the backing material, and it would seem as though a well driven cement yarn joint is more efficient than one similarly driven, composed of all yarn.

Lead wool and yarn joints made up with large hammers (either hand or pneumatic) are much more efficient than similar joints driven by small hammers. Tests show that the compression of the lead wool itself is as great with small as with large hammers. Here again the compression of the lead wool itself has no effect upon the efficiency of the joint. The difference, therefore, must be the effect upon the yarn back of the lead wool. With the large hammers (both hand and pneumatic) a heavy blow is obtained which is probably transmitted through the lead wool and compresses the yarn. With the small pneumatic hammer, the effect is probably more superficial, and the blow is not transmitted to the yarn.

The greater the quantity of lead wool used in a joint, the more efficient the joint. This is probably due to the better compression of the yarn (even though the quantity may be slightly less) as well as to the fact that such of the lead wool as is not in the lead crease does undoubtedly assist in making a joint tight and in resisting movement.

The great variation in performance between the two joints made up with alternate layers of lead and yarn still leaves open the question as to whether this does or does not make a better joint.

The tests seem to show conclusively that the yarn is a very important factor in the tightness of a joint. The mere fact that the individual performance of joints containing yarn which apparently are similar in every way (compare Nos. 14 and 15, Nos. 6 and 18 and Nos. 22 and 23) may differ so much more than that of joints containing no yarn (compare Nos. 6, 7 and 8), would seem to indicate a variation in the character of the yarn portion of the joint. The fact that a smooth spigot piece does not improve the quality of the joint, may mean that the character of the present yarn is not such as to allow of a gas-tight joint against a smooth surface, but may require a roughened one.

In the light of our present knowledge, it would seem as though while the use of lead wool with a cement backing probably gives a very efficient joint, for practical reasons it is not desirable. The use of about 1¼ inch of lead wool with a yarn backing, if the yarn is thoroughly compressed, should make a very efficient joint. Caulking should be done either by hand or by the large pneumatic hammer, and not with the small pneumatic hammer. It is probable that the bells should be cast without the lead groove.

Recommendations.—It is believed that experiments should be continued on the assumption that the yarn is the important factor in the efficiency of a joint, and that these experiments should include the following:

The use of a roughened spigot piece with no bead.

Trial of various methods of applying and compressing the yarn. One method would be to use cast lead of such a shallow depth that the driving blow would be transmitted to the yarn, and when once compressed, the lead would hold it in position.

Trial both in the laboratory and in the street of various kinds of yarn.

Mr. Walton Forstall (Philadelphia): (Written discussion communicated.)—This subject is one that until lately has had very little attention, with the result that practice throughout this country has varied almost with each city and each particular engineer. In connection with pipe 12-inch and smaller in size, records extending over 15 years indicating practically no leaks with cement joints, combined with the fact that the total labor and material cost of a 6-inch cement joint is less than 8 cents, seem to put the burden of proof very strongly on any engineer that continued to use anything but cement for these sizes; and yet it is a well-known fact that many cast lead and lead wool joints are being used for even the smallest-sized mains. The more the subject is ventilated, the quicker the truth will come out. As to mains 16-inch and larger in size, there is, as the report indicates, a certain amount of contradictory evidence, and it is quite important that everybody contribute freely their experience on large mains to hasten the proper solution of the problem.

Mr. L. R. Lemoine (Philadelphia): (Written discussion communicated.) In describing under the "Theory of the Joint," the two classes of cast iron main joints, the Committee apparently had in mind only those joints which have been used to a great extent in this country. I believe they should not have overlooked the joints possible with plain end and with threaded cast iron pipe; also, the turned and bored joint, the foreign experience of which has been fairly extensive and quite satisfactory. In my opinion, the degree of satisfaction from the use of any joint is almost in direct proportion to the care exercised in laying the pipe and making the joint.

I am not impressed with the advantages claimed by the use of deep sockets, as I feel that the standard socket, with careful laying and caulking, will give the desired results, especially where lead wool is employed.

Mr. V. von Starzenski (Schenectady): (Written discussion communicated.) Page 313. Flexible joints are mentioned, in which slight movements may take place without leakage, and later it says. "To this class belongs lead joints, etc." I doubt if this is true.

Page 315. The report says: "The lead joint has been used for many years and has usually resulted in small leakages at the joint sooner or later. Based on the fact that there is probably a very slight movement taking place at each joint, we would expect this result to follow." I agree with this latter statement, which is not consistent with the former.

Page 315, last paragraph. There seems little doubt that the conclusion that a stuffing-box joint on rough cast iron, is not desirable.

Page 319. I am glad to see the increased depth of bells specified. We have gone so far as to use 5-inch bells on our 4-inch mains. This may be considered excessive, but our practical conclusions are that it is easier to make the joint with a deeper bell.

Page 319. Are we not going too far if we insist on spacing joints on small mains with wedges instead of packing? The contention that packing is cut too long is not necessarily correct. The packing may be cut to correct lengths and used to lift the pipe. If by any chance it should be too long, it can be very easily cut off with the caulking hammer against the edge of the pipe bell.

Page 329. In speaking of the combination joint, I do not see why the lead wool should not be placed ahead of the cement, avoiding the delay which is otherwise necessary, to wait until the cement is set. It also seems to me that if the manner recommended were followed, the cement joint would be loosened if lead caulking took place 24 hours after the joint had set. This may be good practice, but from a theoretical point of view, it does not appeal to me.

The President: The report of the Committee on Pipe Standards, of which committee Mr. W. Cullen Morris is Chairman, we will now call for.

Mr. W. Cullen Morris (New York): I will ask that it be read by title, Mr. Chairman.

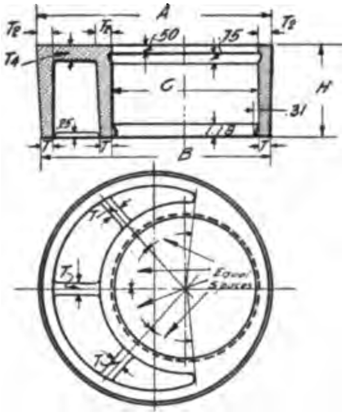
The President: The report of the Committee on Pipe Standards will be read by title and accepted.

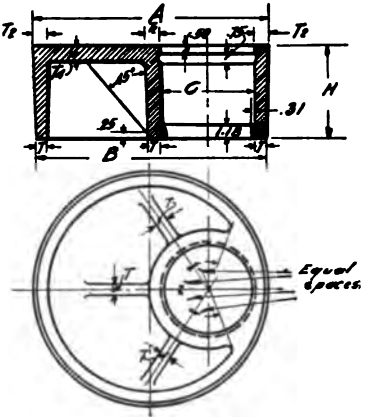
REPORT OF THE COMMITTEE ON PIPE STANDARDS.

In the preparation of the standard specifications for cast iron pipe and special castings adopted in 1911 and 1913, the Committee realized that unusual conditions might suggest extension to the specials provided in the specifications. It believed the greatest good would obtain by not requiring the founders to carry a larger number of patterns than would be called for in usual practice, and the present Committee is of the same opinion.

A limited demand has at times arisen for additional specials, and this Committee suggested to the Technical Committee that it be empowered to approve the design of specials submitted for its consideration, and if it seemed advisable, to publish in the Gas Institute *News* the approved design. This approval, however, was not to be an extension of the present standards, but merely an assurance to the founders or customers that the specials conformed in design with the plan and general scheme

LARGE SIZE BUSHINGS.





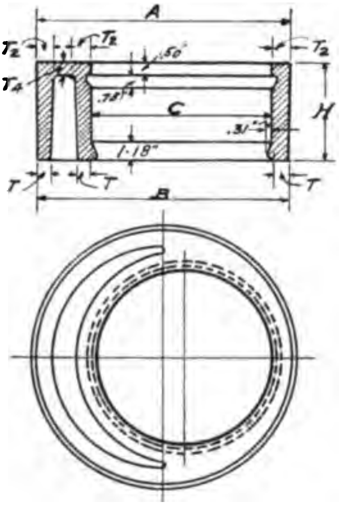
Nominal diameter (inches)	Dimensions in inches							Approx. weight in pounds
	A	B	C	H	T	T_2	T_4	
16 x 6	17.50	17.30	7.90	5.00	0.62	0.72	1.00	112
16 x 8	17.50	17.30	10.05	5.00	0.62	0.72	"	107
16 x 10	17.50	17.30	12.10	5.00	0.62	0.72	"	104
16 x 12	17.50	17.30	14.20	5.00	0.62	0.72	"	84
20 x 6	21.70	21.50	7.90	5.00	0.68	0.78	"	155
20 x 8	21.70	21.50	10.05	5.00	0.68	0.78	"	144
20 x 10	21.70	21.50	12.10	5.00	0.68	0.78	"	145
20 x 12	21.70	21.50	14.20	5.00	0.68	0.78	"	141
20 x 16	21.70	21.50	18.40	5.00	0.68	0.78	"	109
24 x 6	25.90	25.70	7.90	5.50	0.76	0.86	"	233
24 x 8	25.90	25.70	10.05	5.50	0.76	0.86	"	232
24 x 10	25.90	25.70	12.10	5.50	0.76	0.86	"	225
24 x 12	25.90	25.70	14.20	5.50	0.76	0.86	"	220
24 x 16	25.90	25.70	18.40	5.50	0.76	0.86	"	202
24 x 20	25.90	25.70	22.85	5.50	0.76	0.86	"	162
30 x 6	31.84	31.64	7.90	5.50	0.85	0.95	"	319
30 x 8	31.84	31.64	10.05	5.50	0.85	0.95	"	324
30 x 10	31.84	31.64	12.10	5.50	0.85	0.95	"	318
30 x 12	31.84	31.64	14.20	5.50	0.85	0.95	"	321
30 x 16	31.84	31.64	18.40	5.50	0.85	0.95	"	300
30 x 20	31.84	31.64	22.85	5.50	0.85	0.95	"	270
30 x 24	31.84	31.64	27.05	5.50	0.85	0.95	"	234
36 x 6	38.06	37.86	7.90	5.50	0.95	1.05	"	451
36 x 8	38.06	37.86	10.05	5.50	0.95	1.05	"	447
36 x 10	38.06	37.86	12.10	5.50	0.95	1.05	"	446
36 x 12	38.06	37.86	14.20	5.50	0.95	1.05	"	448
36 x 16	38.06	37.86	18.40	5.50	0.95	1.05	"	429
36 x 20	38.06	37.86	22.85	5.50	0.95	1.05	"	415
36 x 24	38.06	37.86	27.05	5.50	0.95	1.05	"	387
36 x 30	38.06	37.86	32.99	5.50	0.95	1.05	"	305

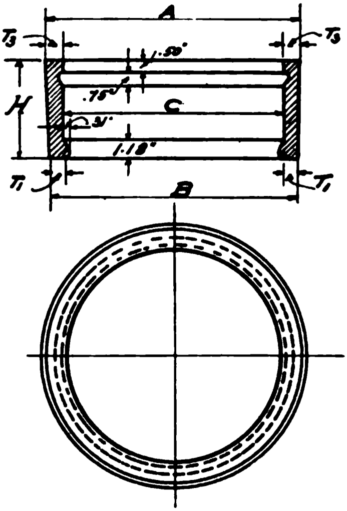
Approved for Design by the Committee on Pipe Standards, 1915.

A. G. I. CAST IRON PIPE STANDARDS—BUSHINGS.
Supplement to page 20 (Standard Specification).

Nominal diameter (inches)	Dimensions in inches									Approx. weight in pounds
	A	B	C	H	T	T_1	T_2	T_3	T_4	
10 x 4	11.20	11.0	5.80	4.50	0.49	—	0.59	—	1.0	50
12 x 4	13.30	13.10	5.80	5.0	0.54	—	0.64	—	1.0	70

BUSHINGS.
December 1911. Revised August, 1915.





Nominal diameter (inches)	Dimensions in inches									Approx. weight in pounds
	A	B	C	H	T	T_1	T_2	T_3	T_4	
6 x 3	7.0	6.80	4.60	4.50	0.43	—	0.53	—	1.0	21
6 x 4	7.0	6.80	5.80	4.50	—	0.50	—	0.60	—	13
8 x 4	9.15	8.95	5.80	4.50	0.45	—	0.55	—	1.0	33
8 x 6	9.15	8.95	7.90	4.50	—	0.525	—	0.625	—	18
10 x 4	11.20	11.0	5.80	4.50	0.49	—	0.59	—	1.0	50
10 x 6	11.20	11.0	7.90	4.50	0.49	—	0.59	—	1.0	57
10 x 8	11.20	11.0	10.05	4.50	—	0.475	—	0.575	—	20
12 x 4	13.30	13.10	5.80	5.0	0.54	—	0.64	—	1.0	70
12 x 6	13.30	13.10	7.90	5.0	0.54	—	0.64	—	1.0	72
12 x 8	13.30	13.10	10.05	5.0	0.54	—	0.64	--	1.0	61
12 x 10	13.30	13.10	12.10	5.0	—	0.50	—	0.60	—	28

of dimensions adopted in the standard specifications. This authority was given by the Board of Directors.

During the year, the Committee approved at the request of a foundry the design for large size bushings 16 by 6 to 36 by 30. The approved design accompanies this report.

During the month of August, a request was made for an extension of the standards to include bushings 10 by 4 and 12 by 4. Your Committee thinks that it is at least an open question whether, on the few occasions where the above size reductions will be required, it would not be just as good practice to make the reduction to 6 inch by means of one of the standard bushings, and then from the 6 inch to 4 inch by a standard reducer. As, however, the request involves the addition of only two patterns to the standards, it has been acceded to, and the plate of bushings as so amended is submitted with this report for the approval of the Institute and incorporation in the standards.

Your Committee believes in future issues of the standard specifications, the plates should be numbered so as to facilitate reference and avoid possible errors.

W. CULLEN MORRIS, *Chairman,*
WALTON FORSTALL,
L. R. LEMOINE.

MR. WALTON FORSTALL (Philadelphia): (Written discussion communicated.) This Committee is needed for some time to come, if not for all time, in order to receive suggestions as to possible changes in the standards, and also to hasten their universal adoption by advertising them to user and maker alike.

THE PRESIDENT: The next is the report of the Committee on International Uniform System of Pipe Threads.

REPORT OF THE COMMITTEE ON INTERNATIONAL UNIFORM SYSTEM OF PIPE THREADS.

Your Committee has held during the early part of the year several meetings with a similar committee of the American Society of Mechanical Engineers. Due to the conditions that exist abroad, further meetings of the International Committee have been interrupted, and there is no further progress to report.

W. Cullen Morris, *Chairman,*
Alten S. Miller,
H. Russell.

The President: The next is the report of the Committee on Refractory Materials.

REPORT OF THE COMMITTEE ON REFRACTORY MATERIALS.

The work of the Refractory Materials Committee this year, as last, has been carried on jointly with the Gas Refractories Committee of the Refractories Manufacturers' Association and with the assistance of the Bureau of Standards. The work done has been accomplished under the direction of the combined Committees, and the report submitted is in reality a joint report.

The efforts of the Committees this year have been devoted chiefly to the preparation of standard specifications covering fireclay and silica material for gas works' use, having in mind more especially material for carbonizing chambers and the refractory qualities of such materials.

The need of standard specifications as a guide to user, builder and maker was early recognized by all members of the Committee. It was felt that this was the first step necessary in order to place the use and manufacture of gas works' refractories upon a more scientific basis. Probably no material used by the gas engineer has been so neglected, so little studied, and so much abused as his firebrick, while at the same time no other material is of such importance in the successful and economical operation of his plant. Certainly no subject has been productive of more disputes between user and builder. We feel that a careful study and use of the specifications submitted with this report will do much to eliminate the misunderstanding and controversy which has hitherto existed between the buyer and the maker, and will result in more intelligent use, purchase and manufacture of such material.

As our knowledge of refractories increases, it will doubtless be necessary to alter the specifications, but we feel that in their present form they truly represent the state of the art. They come as the result of two years' work by the Committees, wherein user, builder and maker have been equally represented, several years' work by the Bureau of Standards, and an elaborate series of tests conducted this year under the direction of the Committees by the Bureau of Standards, and a separate series of tests conducted by The United Gas Improvement Company and by the Harbison-Walker Refractories Company. Reports of these investigations are included with this report.

From the knowledge gained from these reports and other investigations, the Committees have been able to agree upon the terms of the specifications as submitted below. The specifications are intended to cover material for gas works' use, primarily its use in carbonizing chambers. Refractoriness under load is without question the most important quality of refractories for the gas engineer, and ordinarily these materials are valued on this basis. Other qualities, such as resistance to abrasion at various temperatures, resistance to sudden temperature changes, conductivity, slagging action, and so on, are important and are secured more readily where the material is subject to low temperatures, but at high temperatures, all are secondary to refractoriness. The material must, first of all, possess the desired refractoriness, and then as much or as little of the other qualities as the manufacturer can produce. It is obviously impossible to produce any one material that will possess all the desired qualities.

STANDARD SPECIFICATIONS FOR SILICA BRICK AND SHAPES FOR GAS WORKS' USE.

Submitted by the Joint Refractory Committees of the Refractories Manufacturers' Association and the American Gas Institute.

(1) Material: (*a*) Material shall be designated as Silica Material only when content of silica exceeds 94 per cent.

(*b*) It shall contain not less than 1.7 per cent. of lime, not more than 3 per cent., unless specified otherwise for special purposes.

(*c*) It shall contain not more than 1.7 per cent. of iron oxide (Fe_2O_3).

(2) Refractoriness: (*a*) This material when reheated under a load of 25 pounds per square inch to 1500° C. (2732° F.) and held at this temperature for one and one half (1½) hours by the method given in the Appendix, shall not show execessive permanent swelling or any other vitrification or other deterioration. Permanent swelling above one per cent. (1 per cent.) shall be considered excessive.

(3) Size, Shape and Uniformity: (*a*) Material under these specifications shall have no spongy spots, and shall be uniformly solid throughout; the corners shall be well filled and the material shall be of homogeneous solidity. Shapes shall not be bent or warped from a true plane to a greater extent than 3/16 inch to the foot, measured along the diagonal of the piece. No material broken or so cracked or damaged as to render it unsuitable for the purpose intended shall be accepted.

(*b*) No shape shall have any dimension with more than ⅛ inch variation over or under that shown on drawing, excepting that shape having one or more dimensions exceeding 12 inches, and less than 36 inches, may have variations in such dimensions not exceeding 3/16 inch from drawing over or under. Not over 65 per cent. of the shapes shall vary in any one direction from drawing dimension.

(*c*) This clause is intended to cover standard 9 inch Silica

Brick, 9 inches x 4½ inches x 2½ inches. Such brick shall be essentially rectangular and when ten (10) bricks are laid dry, they shall measure, when piled flat, not more than 25½ inches or less than 24¾ inches in height; or measure more than 91¼ inches or less than 89 inches when laid end to end; nor more than 45⅝ inches nor less than 44½ inches when laid edge to edge.

(4) Silica Cement: Silica cement shall be ground and screened so that 100 per cent. will pass through a twenty (20) mesh W. S. Tyler Standard Screen (.0328 inch opening–.0172 inch wire), and 70 per cent. will pass through a forty-eight (48) mesh Tyler Standard Screen (.0116 inch opening—.0092 inch wire.)

Cement when placed as a joint between two brick and tested in the same manner as specified for Silica Material shall not flow from the joint and shall make a satisfactory bond.

Appendix: The test referred to in Section 2 shall be made in an approved method as follows:

Load Test (Silica): This specification covers only the fundamental features of the test.

A detailed description of one form of apparatus is given in Technologic Paper No. 7, Bureau of Standards, page 48, and another form is described in the report of the Refractories Committee of the American Gas Institute of 1915.

Test Specimen: The test specimen shall consist, whenever possible, of a standard 9 inch brick placed vertically on end. In the case of blocks or shapes, sections approximately (9 inches x 4½ inches x 2½ inches = 228 millimeters x 114 millimeters x 64 millimeters) shall be cut utilizing as far as possible existing plane surfaces. The ends of the specimen shall be either ground so that they are parallel and perpendicular to the vertical axis, or if this is impossible, they shall be bedded in a neutral cement so that the specimen is perpendicular to the base of the furnace.

The test specimen shall be measured before testing, making not less than five observations in each direction to within plus or minus (0.02 inch = 0.5 millimeter). The average dimensions shall be reported, and the cross section calculated.

Furnaces: The furnace shall be approximately cubical in form and should be not less than (18 inches = 460 millimeters) in any internal dimension. The heating means shall be such as will insure uniform temperature in all parts of the furnace, be under complete control, and be so arranged that no flame may impinge upon the test specimen.

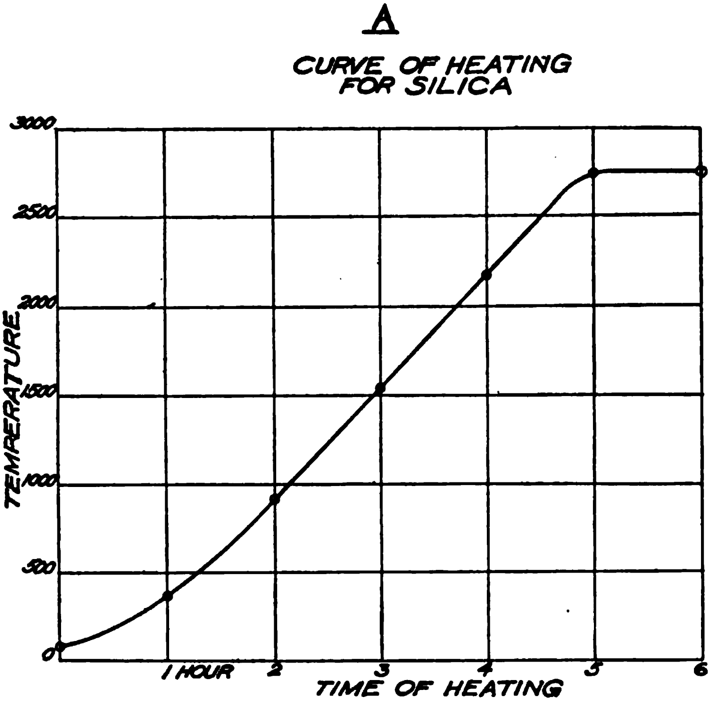


Fig. 1.—Curve "A" of heating for silica.

The test specimen shall occupy approximately the center of the furnace, and should rest on a block of some highly refractive material having a minimum expansion or contraction. Refrax carborundum brick has been found satisfactory. This in turn should rest on a heavy concrete pier or should be adequately supported in some other suitable manner to insure rigidity and freedom from vibration and distortion during the test. At the top of the test specimen, a block of similar highly refractive material should be placed extending through the furnace top to receive the load.

Heating: The heating shall be in accordance with the accompanying curve "A," Fig. 1.

The temperature may be measured either with a calibrated Platinum-Rhodium Thermocouple encased in a double protecting tube with the end not more than (1 inch = 25 millimeters) from the side or edge of the specimen and approximately opposite the center; or with some form of optical pyrometer that has been calibrated against a Thermocouple in the furnace. If the Thermocouple is used, the cold end temperature should be kept constant in melted ice if possible. With either form of pyrometer, a recording form of indicator is recommended.

Loading: The load is calculated from the average cross-section as determined on the untested specimen and the requirement of the test.

It may be applied in any convenient manner, but the arrangement of the apparatus shall be such as will insure accuracy in the applied load and freedom from eccentric loading both in the original application and during the testing. It is advisable to observe and record the change in the length of the specimen during the test.

Completing the Test: At the expiration of the time of heating as required by the specifications, the supply of heat shall be stopped and the furnace allowed to cool during not less than 10 hours before removing the load and examining the test specimen.

After the test specimen has cooled to the room temperature, it shall be remeasured as before described, and the change in length recorded and reported as percentage of the original length. It is recommended that a photograph be made of the specimen before and after testing, as yielding valuable information at a minimum time and expense.

Silica material will stand higher load and temperature conditions than required by Section 2, but the difficulty of making tests increases greatly at temperatures higher than specified.

Silica material complying with these tests will have a temporary expansion when heated to test temperature of about 3/16 inch per foot.

The term "Shapes" applies to forms other than the twenty-eight (28) "Standard 9 inch and 9 inch Brick Shapes adopted by the Refractories Manufacturers' Association July 29th, 1913.

Explanatory Notes on Silica Specifications.

Material: The chemical components of silica material are confined within narrow limits and have been closely determined. As silica material is an artificial mixture, no great difficulty is encountered in making the mixtures so as to secure a uniform product. Brick with less than 94 per cent. silica fail to have the necessary refractory qualities, and with less than 1.7 per cent. lime, the bond cannot be secured and bricks fail to hold together.

Refractoriness: Silica material conforming to these specifications will safely stand temperatures of 3,000° F. under load of 25 pounds per square inch without showing signs of fusion. Owing to the difficulty of conducting a test at these temperatures, your Committee has adopted the temperature of 2732° F. (1500° C.), which temperature will serve equally well to reject any material not conforming to the requirements of the specifications.

Size, Shape and Uniformity: These requirements have been fixed after careful consideration by the Committees, and we feel will go far to insure a uniform product.

Silica Cement: Often the failure of silica material construction has been due not to the silica material, but to the cement used as a bond. For this reason it was deemed advisable to include this clause which will insure a satisfactory material and will emphasize the importance of paying attention to the quality of the cement used.

STANDARD SPECIFICATIONS FOR FIRECLAY BRICK, SHAPES AND RETORTS FOR GAS WORKS' USE.

Submitted by the Joint Refractories Committees of the Refractories Manufacturers' Association and The American Gas Institute.

(1) Material (*a*) Material shall be designated as Fireclay Material when it contains not more than 75 per cent. silica in the burnt state. Material containing from 75 to 90 per cent. silica in the burnt state shall be included if it conforms to these specifications, and shall be known as Silicious Clay Material. The material known as Quartzite is an artificial mixture of fireclay and silica containing from 70 to 80 per cent. silica in the burnt state, and is included in these specifications.

(*b*) A complete chemical analysis of the material shall be provided when required.

(*c*) Firebrick and Shapes shall be divided into three (3) qualities.

(*d*) Retorts shall be of first quality only.

(2) Refractoriness: (*a*) First quality material shall be subdivided into Grade A and Grade AA.

(*b*) First quality Grade A material, when reheated under a load of 25 pounds per square inch to 2462° F. (1350° C.) and held at this temperature for 1½ hours by the method given in the Appendix, shall not show excessive permanent swelling or shrinkage or any vitrification or other deterioration. Permanent swelling or shrinkage above two and one half per cent. (2½ per cent.) shall be considered excessive.

First quality Grade AA material, when reheated under a load of 25 pounds per square inch to 2552° F. (1400° C.) and held at this temperature for one and one-half (1½) hours by the method given in the Appendix, shall not show excessive permanent swelling or shrinkage or any vitrification or other deterioration. Permanent swelling or shrinkage above one and one-half per cent. (1½ per cent.) shall be considered excessive.

Note: Tests conducted by the Committee show that there is very little fireclay material on the market at the present time which will meet the refractory requirements of Grade AA. It has been deemed wise to include this grade in order to provide for its future production and purchase.

(*c*) Second quality material shall be tested in the same manner as first quality Grade A material, except that the load shall be 25 pounds per square inch, and the temperature of reheating shall be 2372° F. (1300° C.), and under these conditions shall not show excessive permanent swelling or shrinkage or any vitrification or other deterioration. Permanent swelling or shrinkage above two and one-half per cent. (2½ per cent.) shall be considered excessive:

(*d*) Third quality material shall be tested in the same manner as first quality Grade A material, except that no load shall be applied, and the temperature of reheating shall be 2012° F. (1100° C.), and under these conditions shall not show excessive permanent swelling or shrinkage or any vitrification or other deterioration. Permanent swelling or shrinkage above two and one-half per cent. (2½ per cent.) shall be considered excessive.

(3) Size, Shape and Uniformity: (*a*) Materials under these specifications shall have no spongy spots and shall be uniformly solid throughout; the corners shall be well filled and the material shall be of homogeneous solidity. Retorts shall not be bent, warped or out of alignment more than one-half of one per cent. (5/10 per cent). Brick and shapes shall not be bent or warped from a true plane to a greater extent than 3/16 inch to the foot measured along the diagonal of the piece. No material broken or so cracked or damaged as to render it unsuitable for the purpose intended shall be accepted.

(*b*) No shape shall have any dimension with more than ⅛ inch variation over or under that shown on drawing, excepting that shapes having one or more dimensions exceeding 12 inches and less than 36 inches may have variations in such dimensions not exceeding ¼ inch from drawing over or under. Not over 65 per cent. of the shapes shall vary in any one direction from the drawing dimensions. No retort or retort section shall have any cross sectional dimensions with more than ⅛ inch per foot variation over or under that shown on drawing.

(*c*) This clause is intended to cover first and second quality standard 9-inch brick, 9 inches x 4½ inches x 2½ inches. Such brick shall be essentially rectangular, and when ten brick are laid dry, they shall measure when piled flat not more than 25¾ inches or less than 24½ inches in height, or measure more than 91¼ inches or less than 89 inches when laid end to end, nor more than 45⅝ inches nor less than 44¼ inches when laid edge to edge.

(*d*) Third quality brick shall not be restricted as to dimensions.

(4) Cement: (*a*) All cement clay shall be made of essentially the same grade of materials as the material to be laid.

(b) All cement clay shall be ground and screened so that 100 per cent. will pass through a fourteen (No. 14) W. S. Tyler Standard Screen.

Appendix.

Load Test (Fireclay): This specification covers only the fundamental features of the test.

A detailed description of one form of apparatus is given in Technologic Paper No. 7, Bureau of Standards, page 48, and another form is described in the report of the Refractories Committee of the American Gas Institute of 1915.

Test Specimen: The test specimen shall consist, whenever possible, of a standard 9 inch brick placed vertically on end. In the case of blocks or shapes, sections approximately (9 inches x 4½ inches x 2½ inches = 228 millimeters x 114 millimeters x 64 millimeters) shall be cut utilizing as far as possible existing plane surfaces. The ends of the specimen shall be either ground so that they are parallel and perpendicular to the vertical axis, or if this is impossible, shall be bedded in a neutral cement so that the specimen is perpendicular to the base of the furnace.

The test specimen shall be measured before testing, making not less than five observations in each direction to within plus or minus (0.02 inches = 0.5 millimeters). The average dimensions shall be reported, and the cross section calculated.

Furnaces: The furnace shall be approximately cubical in form and should be not less than (18 inches = 460 millimeters) in any internal dimension. The heating means shall be such as will insure uniform temperature in all parts of the furnace, be under complete control, and be so arranged that no flame may impinge upon the test specimen.

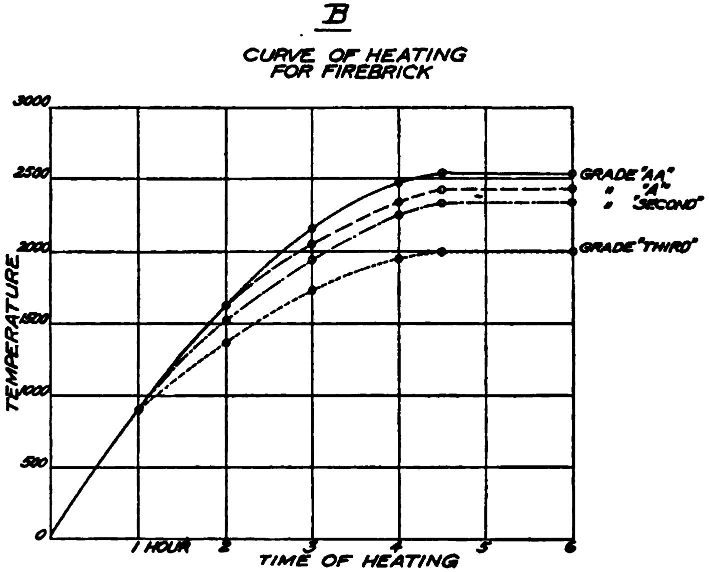


Fig. 2.—Curve "B" of heating for firebrick.

The test specimen shall occupy approximately the center of the furnace, and should rest on a block of some highly refractive material having a minimum expansion or contraction. Refrax carborundum brick has been found satisfactory. This in turn should rest on a heavy concrete pier or should be adequately supported in some other suitable manner to insure rigidity and freedom from vibration and distortion during the test. At the top of the test specimen a block of similar highly refractive material should be placed extending through the furnace top to receive the load.

Heating: The heating shall be inaccordance with the accompanying curve, "B," Fig. 2, which gives the rate for the different grades of material.

The temperature may be measured either with a calibrated Platinum Rhodium Thermocouple encased in a double protecting tube with the end not more than (1 inch = 25 millimeters) from the side or edge of the specimen and approximately opposite the center, or with some form of optical pyrometer that has been calibrated against a Thermocouple in the furnace. If the Thermocouple is used, the cold end temperature should be kept constant in melted ice if possible. With either form of pyrometer, a recording form of indicator is recommended.

Loading: The load is calculated from the average cross-section as determined on the untested specimen and the requirement of the test.

It may be applied in any convenient manner, but the arrangement of the apparatus shall be such as will insure accuracy in the applied load and freedom from eccentric loading both in the original appplication and during the testing. It is advisable to observe and record the change in the length of the specimen during the test.

Completing the Test: At the expiration of the time of heating as required by the specifications, the supply of heat shall be stopped and the furnace allowed to cool during not less than five hours before removing the load and examining the test specimen.

After the test specimen has cooled to the room temperature, it shall be remeasured as before described, and the change in length recorded, and reported as percentage of the original length. It is recommended that a photograph be made of the specimen before and after testing, as yielding valuable information at a minimum time and expense.

Shapes: The term "Shapes" applies to forms other than the twenty-eight (28) "Standard 9 inch brick and 9 inch

Brick Shapes adopted by the Refractories Manufacturers' Association, July 29th, 1913.

Explanatory Notes on Fireclay Specifications.

Material: Fireclay material covers material with a wide range of composition. The intent of the specifications is to include all refractory material composed of silicate of aluminum with varying percentage of silica and fluxes ranging from pure kaolin with 54 per cent. silica and 46 per cent. aluminum, to material containing 90 per cent. silica. The fluxes commonly present are iron ioxide, alkalies, lime and magnesia.

Chemical Analysis: The chemical composition of fireclay material has an important bearing upon its refractory qualities. This has been discussed by Dr. A. V. Bleininger and Mr. G. H. Brown of the Bureau of Standards (See Technologic Paper No. 7—"The Testing of Clay Refractories, with Special Reference to their Load Carrying Capacity at Furnace Temperatures"). The sum of the basic fluxes is represented by the expression "RO," and it is shown that in the empirical formula used in ceramic studies, this "RO" content becomes very prominent at about 0.2 molecular equivalent. In the empirical formula, alumina is made equal to unity. The empirical formula is calculated from the analysis by dividing the per cent. of each component by its molecular weight. The equivalents of K_2O, Na_2O, CaO, Mg and TiO, thus obtained, are added together and make the "RO" equivalent. Then, by dividing the alumina equivalent, that is making it equal to unity, there is obtained an expression for the clay of XRO, $1Al_2O_3$, $YSiO_3$. It is shown that in materials with high refractory qualities the X in this expression should not exceed .22.

The chemical composition has then an important bearing on the refractory qualities of the material. The behavior of the material as regards expansion and conductivity is also dependent upon the chemical composition, especially the per cent. of silica present. The purchaser should consider the chemical analysis where the qualities of refractoriness or expansion are important.

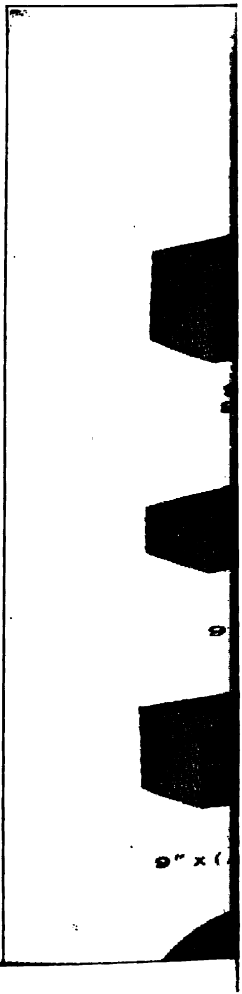
The division of gas works' refractory material into three qualities, dependent upon their degree of refractoriness, we believe will lead the user and builder to purchase material more nearly suited to the use to which such material is to be put than has been the practice in the past. Where a high degree of refractoriness is not required, other qualities, such as conductivity, resistance to abrasion, etc., are often of prime importance, and these are much easier secured if refractoriness is of secondary consideration.

As retorts are subject to the maximum temperature, refractoriness is of greatest importance in such material, and at the temperatures prevailing in modern practice, they must meet the requirements as set forth for first quality material.

Refractoriness: This quality has been made the basis of differentiating the different grades of material, for the reason that this quality in material intended for gas works' use is in general of first importance. It is the aim of your Committee to determine, in time, the requirements which material should possess in order to best fulfill the conditions of use, and to prepare sets of special specifications, covering these specific uses. In many of these uses refractoriness will be of secondary consideration. The accomplishment of this purpose will require a careful study of operating conditions and of the manufacture of refractory materials. Until such time as this can be accomplished we must rest content with a set of specifications of a general nature, wherein particular stress is laid upon the quality—refractoriness under load.

The determination of the specifications as to refractoriness for the different grades is based upon the requirements as determined from operating and construction conditions, and the tests of refractory material now on the market. The specifications are then a compromise between what the user and builder would like to have and what the manufacturer can produce, as disclosed in the investigations which the Committees have conducted.

The so-called fusion or melting point of fireclay refractories has been replaced in the specifications by the load test, and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the fixing of an allowable expansion or contraction under this test. The reason for this substitution is that the fusion point of fireclay refractories is at best indefinite, difficult of determination, and not representative of operating conditions. The fusion point is determined by noting the behavior of a test piece under "no load" other than its own weight, at varying temperatures. A great deal of refractory material thus tested will show a very high fusion point and yet fail completely under a load test. Inasmuch as all this material in operation is subjected to some load, the fusion test is unreliable, if it is to be used as a criterion of what may be expected of the material in practice. The refractory requirements therefore have been based entirely upon a "load test." The amount of the load has been fixed at 25 pounds, as a study of operating conditions disclosed the fact that this is about the maximum loading which is met with at the condition of maximum temperature. From the tests made by the Committee, the work done by the Bureau of Standards, The United Gas Improvement Company, the Harbison-Walker Refractories Company, and others, have been determined the different temperatures and allowable amounts of contraction for the different grades of material. The Committee believes that the determinations as made are such as will protect the purchaser without requiring the impossible or the impractical of the manufacturer. As the art of manufacture improves, it may be possible to make the "refractoriness" requirements more rigid.

Size, Shape and Uniformity: The specifications under this clause have been adopted after careful consideration by the Committees, and will tend to insure the use and manufacture of a uniform product. Brick and 9 inch brick shapes are those adopted by the Refractories Manufacturers' Association and shown in Plate 5, Fig. 3.

Conditions Refractory Material Meets in Practice.

Preliminary to the attempts to fix the standards, a careful investigation was made of the conditions as regards load and temperature to which refractory material is subjected in practice in the various types of carbonizing plants. Representative plants of the various types were solicited for information, and the results are shown in Table A. The significant points to be noted are that a temperature of 2500° F. (1371° C.) and higher may be expected in the combustion chambers of all types, and that a load of 25 pounds per square inch at such temperature is not uncommon. Usually, however, at the point of maximum temperature, the load is considerably below this. A considerable factor of safety, approximating 250° F. should be allowed for to provide for unusual operating conditions.

The diversity of opinion among the members of the Committees over the refractoriness clause of the specifications and the method of conducting the refractory test and the general lack of any definite knowledge on these points, showed clearly that it would be necessary to conduct a series of tests designed to show the behavior of refractory material, especially fireclay material under varying loads and at varying temperatures, and also the behavior of a single brick as against a pier under the test conditions. The Bureau of Standards, through Dr. A. V. Bleininger, volunteered to conduct these tests, and at the same time The United Gas Improvement Company started a similar investigation for their own information. Through the courtesy of The United Gas Improvement Company your Committee is able to present some of the results of its work done under the direction of Mr. W. H. Fulweiler in the report of Mr. E. W. Desher. The work undertaken by the Bureau of Standards was carried on under Dr. Bleininger's direction by Mr. G. H. Brown, and it is perhaps not amiss to state here that this work consumed the major portion of Mr. Brown's time for a period of about five months. The reports follow:

The Behavior of Firebricks Under Different Load Conditions at Varying Furnace Temperatures.

(Report of work done by Clay Products Section of the Bureau of Standards, Pittsburgh, Pa., in co-operation with the Refractory Materials Committee of the American Gas Insti-

Return Flue Gas System used	Answer to Quest. #1	REMARKS
		* Temperatures Estimated
		a - Temperature next to Last Pass
		* Temperatures estimated
No	No	b- Temperature using return flue system.- Much lower now that steam is used under grates
No	Yes	A - Station A Plant B- " B "
Yes	No	
Co$_2$ ref. by Steam Jet	No	
	No	
No		ab.- abnormal temperature reached during certain periods, such as cleaning fires etc.
No	No	
	Yes	
No	Yes	
	Yes	Under conditions of gross neglect, temperatures might rise to fusion point of brick
		Abnormal Temp. during clinkering
No	Yes	

temperatures.

tute and the Gas Refractories Committee of the Refractories Manufacturers' Association).

"The refractories used in the construction of gas retort installations are, especially in the case of the benches and piers, subject to considerable pressure at temperatures fluctuating between 2400° and 2600° F. (1315° C. and 1427° C.). The loads may be as high as 25 pounds per square inch. In aiming to secure materials which will withstand these conditions in the greatest measure by means of suitable specifications, it is essential to understand the relation between load carrying ability and temperature for different classes of refractories, as well as to establish testing conditions permitting of estimating the desired quality with a reasonable degree of certainty.

Some work has been done along this line by the Bureau of Standards Technologic Paper No. 7, and these investigations were taken as the starting point of the present work. In these tests it was found that with a load of 75 pounds per square inch at 2372° F. (1300° C.) and 50 pounds at 2462° F. (1300° C.), the deformation of clay firebrick was, to a large extent, a function of the refractoriness of the clay, and the temperature of the burning. The ability to carry loads under these conditions is therefore more pronounced the more refractory the clay is and the harder it has been burned. The compactness of the structure, as well as the initial bonded strength, are of assistance in increasing the resistance to crushing, but are not of primary importance. The failure of clay firebrick in the load test, with, say, a load of 50 pounds per square inch, may be attributed either to the softening of the material, in which case the specimen is deformed, often assuming an "S" shaped appearance, or to lack of bonding, in which case the piece does not deform, but fails by shearing. The former kind of failure invariably condemns the material as to its refractory qualities; the second leaves some doubt as to the real refractory nature of the material, since a high grade flint clay brick, poorly bonded, might fracture under these conditions. It is essential, therefore, to reduce the load requirement of the test to the minimum in order to eliminate the shearing of mechanically weak mixtures as much as possible and to insist on fairly high furnace temperatures. Recent work tends to indicate that for high class refractories intended to withstand load conditions, a pressure of 40 pounds per square inch and a temperature of 2462° F. (1350° C.) would bring about the desired differentiation. At about this temperature the softening effect of the fluids which are present becomes marked. Tests at lower temperatures, and with higher pressures are not advisable. As to the degree of permissible deformation, the requirements of each case must be considered. In gas works' practice the load resisting quality must be emphasized, as a deformation as small as possible is desired. Clay firebrick consisting essentially of clay substance containing about 54.5 per cent. of silica and 45.5 per cent. of alumina in the dehydrated state have an inherent tendency to contract upon being subjected to pressure and heating, independent of the content of the fluxes. This is especially pronounced in cases where raw flint fireclay is used in making the bricks. The use of previously burned clay (grog) and a high firing temperature tends to counteract this tendency. In fact, tests are on record where such high clay brick have shown practically no contraction at 2462° F. (1350° C.) and under a load of 40 pounds per square inch.

Clay mixtures containing larger amounts of silica in the form of quartz, more or less finely divided, are less subject to deformation under the above conditions as the silica content increases, even though the general refractoriness is decreased. Silica thus appears to contribute a pronounced rigidity which reaches its maximum in the silica brick. As a rule, the compression is slight for bricks made from silicious clays and nil for silica brick. Even by carrying the temperature to 2678° F. (1470° C.) and maintaining a load of 50 pounds per square inch silica brick show no contraction. This material would be perfect for load carrying purposes in furnaces were it not for the fact that it is more sensitive to sudden heating and cooling than the clay firebrick.

Method of Conducting the Tests.

The load test for firebrick is carried on in a furnace in which the brick is placed on end on a firm foundation, and the load transmitted to it by means of a refractory column extending through an opening in the crown. The load may be applied by means of a lever or beam weighted on one end. It is necessary that the brick be placed on a base, preferably of silica brick which does not give. It is likewise desirable that the ends of the specimen be ground parallel and that it be set up plumb. The steel beam should be so designed that it can be kept level following the contraction of the brick. This is possible by the use of the hand wheel which causes the sliding block carrying the pin taking the up thrust, to move up and down. Such a furnace is illustrated in Fig. 4, which represents the arrangement used at the Clay Products Laboratory of the Bureau of Standards, Pittsburgh. Here the length of the "I" beam is 9 feet, and the distance between the center of the end pin and the point of application 3 feet.

Of course, the load may also be applied direct, using a horizontal member loaded at each end and moving in two guides. Such an arrangement is used in the laboratory of The United Gas Improvement Company, Philadelphia, and is perhaps to be preferred to the beam loaded at one end. Hydraulic or air cylinders might also be used to produce the necessary pressure.

In order to secure comparative results, it is necessary that the temperature of the furnace be increased at an established rate. In the Bureau of Standards' furnace the firing is done by means of natural gas using Fletcher burners supplied with compressed air at about 20 pounds pressure. The combustion gases escape through small apertures on top and in the sides of the furnace. Crude oil might also be used if care is taken to impinge the flame on a low bridge wall. Where it is necessary to use coal as fuel, a forced draft grate furnace would have to be attached and a flue removing the combustion gases through the bottom of the heating chamber.

The rate of firing practiced at the Bureau of Standards Laboratory is shown by the curve of Fig. 5. It will be noted

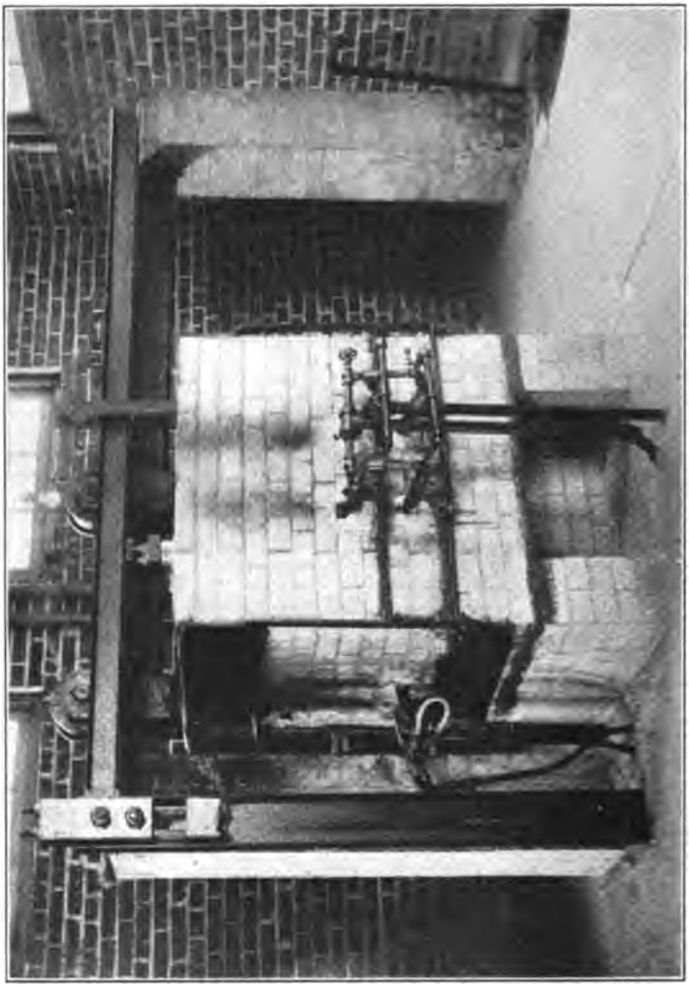


Fig. 4.—Test furnace of Bureau of Standards.

that 4½ hours are taken to reach 2462° F. (1350° C.), and that this temperature is then maintained for 1½ hours. The temperature is controlled by means of a Thermocouple protected by means of a porcelain or fused silica tube.

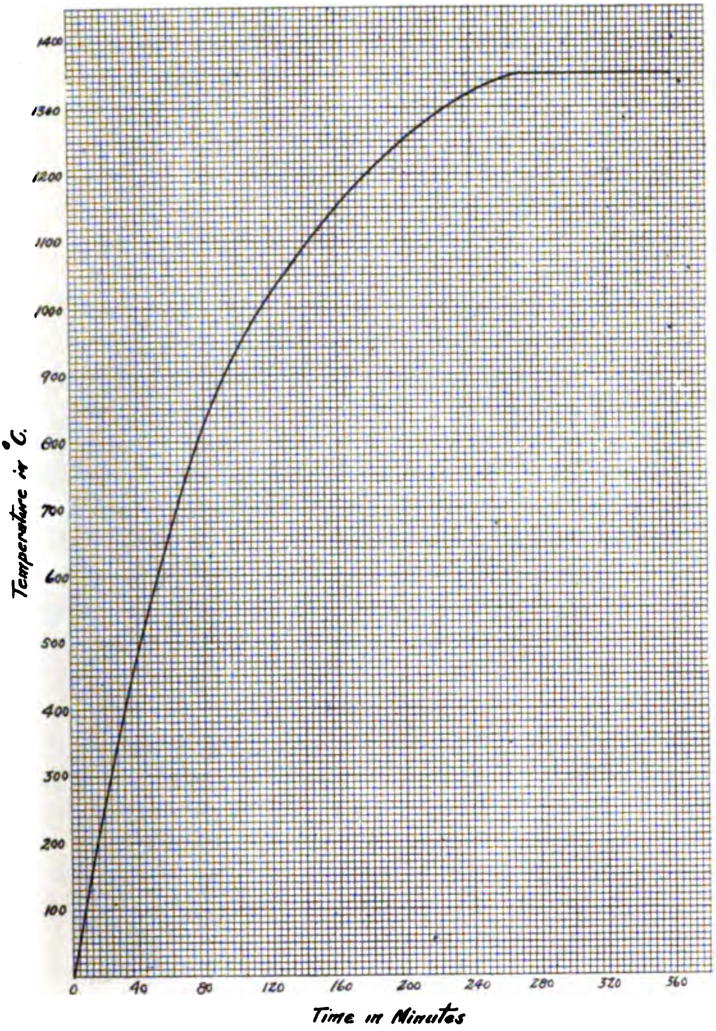


Fig. 5.—Curve of firing of Bureau of Standards.

The back of the furnace is provided with a firebrick door, built into an iron frame which is hung from rollers running on a track. This permits of ready access to the furnace.

Results of Load Tests: The tests carried on for the purpose of securing information desired by the Joint Committee were carried on along three lines;

a. Load tests made upon firebrick piers of 9 inch x 9 inch cross-section and about 15 inches high.

b. Comparison of load tests made upon brick piers and upon bricks placed on end.

c. Effect of different pressures upon bricks tested on end at 1300° and 1350° C.

Pier Tests: In these tests all bricks were surfaced on the two sides by grinding, in order to secure good contact with the use of a minimum amount of mortar. Each pier consisted of 12 bricks laid flat in six courses. The mortar used consisted of 50 per cent. of fireclay grog, ground to pass the 30 mesh sieve, and 50 per cent. of plastic fireclay. A thin coating of mortar was used and the bricks rubbed into position. Each course was carefully leveled. The pier rested on a refractory base above the floor of the furnace. A load of 40 pounds per square inch was applied. The maximum temperature was 2462° F. (1350° C.) which was held for 1½ hours. The results of this series are compiled in Table I.

TABLE I.

No.	Height of pier before test. (Inches)	Height of pier after test. (Inches)	Compression. (Inches)	Compression. Per cent. of height	Kind of firebrick
1	14 1/2	14	1/2	3.44	High clay.
2	15	14 1/2	1/2	3.33	High clay.
3	14 1/8	14 1/2	5/8	4.13	High clay.
4	15	14 5/8	3/8	2.50	Silicious high clay.
5	14 13/16	14 1/2	5/16	2.11	Silicious high clay.
6	15 1/8	15 1/4	1/8	0.82	Silica brick.
7	15	15	0	0.00	High clay heavily grogged.
8	15 1/8	14 3/8	3/4	4.96	High clay.

Attention is called to the characteristic contraction of the three brands of high clay firebrick averaging 3.63 per cent., the lower contraction of the silicious claybrick with a mean of 2.3 per cent., and the negative contraction or expansion of the silica brick.

The lack of contraction on the part of the heavily grogged high clay (high alumina) brick is interesting and suggestive; inasmuch as it indicates the possibility of producing such a product.

Compression of Firebrick Piers and of Bricks on End Tested Under the Same Conditions of Temperature and Pressure.

In this series piers were built and tested as described above at a maximum temperature of 2462° F. (1350° C.) and under a load of 40 pounds per square inch, the final temperature being held for 1½ hours. From the corresponding sets of bricks new individual specimens were selected and tested on end under the same conditions. The results of this work are collected in Table II.

TABLE II.

No.	Per cent. contraction of pier about 15 inches high	Per cent. contraction of brick on end	Kind of firebrick and remarks
A	4.96	6.33	High clay.
B	2.50	3.46	Silicious clay.
C	7.53	7.69	High clay.
D	4.13	4.94	High clay.
E	2.11	3.86	Silicious clay.
F	2.56	3.26	High clay, small pier 4″ x 4″ x 9¾″ used.

From the results it is apparent that the compression of the piers is less than that of the bricks, but the difference is not sufficiently marked to discredit the test of the single brick. The pier test is very troublesome and expensive to make, and the results are not very discriminating.

Relation Between Deformation of Firebrick and Pressure at 2372° F. (1300° C.) and 2462° F. (1350° C.)

Firebricks upon being heated do not begin to show the softening effect due to the fluxes or the disintegration peculiar to the deficiency of bond clay, until a temperature of approximately 2282° F. (1250° C.) has been reached. In fact, at about 1832° F. (1000° C.) they possess greater crushing strength than in the cold state. Even at 2282° F. (1250° C.) the softening effect is but slight and does not become more marked until 2372° F. (1300° C.) has been attained. At 2462° F. (1350° C.) the action becomes decisive and prompt. In order to arrive at the relation between pressure and deformation, single bricks of the same brand and shipment were subjected to loads varying from 0 to 40 pounds per square inch in two series, at 2372° F. (1300° C.) and 2462° F. (1350° C.) respectively. The conditions of heating were those of the standard test, the maximum temperature being maintained for 1½ hours. The brick tested were standard high grade firebrick, submitted for test by the refractory manufacturers. The results of this work are collected in Table III, and are shown graphically in Figs. 6 and 7.

TABLE III.

Temperature 2372° F. (1300° C.)				Temperature 2462° F. (1350° C.)			
No.	Load lbs. per sq. in.	Contraction of brick in length. (Inches)	Contraction of brick in per cent. of length	No.	Load lbs. per sq. in.	Contraction of brick in length. (Inches)	Contraction of brick in per cent. of length
1	50	3/32	1.06	1	40	5/16	3.46
1	40	3/32	1.06	1	25	7/32	2.48
1	25	1/32	0.35	1	15	3/32	1.03
1	0	0	0.00	1	0	0	0.00
2	50	3/16	2.17	2	40	9/32	3.26
2	40	3/16	2.17	2	25	5/32	1.81
2	25	1/16	0.72	2	15	2/16	1.45
2	0	0	0.00	2	0	0	0.00
3	50	11/32	3.83	3	40	7/16	4.82
3	40	9/32	3.11	3	25	5/16	3.50
3	25	5/32	1.73	3	15	5/16	3.44
3	0	0	0.00	3	0	1/16	0.70
4	50	3/32	1.03	4	40	11/32	3.86
4	40	1/16	0.70	4	25	7/32	2.41
4	25	0	0.00	4	15	1/8	1.41
4	0	—	—	4	0	—	—
5	50	5/32	1.80	5	40	9/32	3.26
5	40	3/32	1.08	5	25	1/4	2.89
5	25	3/32	1.08	5	15	3/32	1.08
5	0	—	—	5	0	—	—

In this Table, samples Nos. 1 and 4 were of the silicious clay type, the others were high clay compositions.

Inspection of Fig. 6, showing the deformations obtained for the several pressures at 2372° F. (1300° C.) indicates at once the much lower contraction of the silicious clay bricks as compared with the others, thus establishing a well defined differentiation.

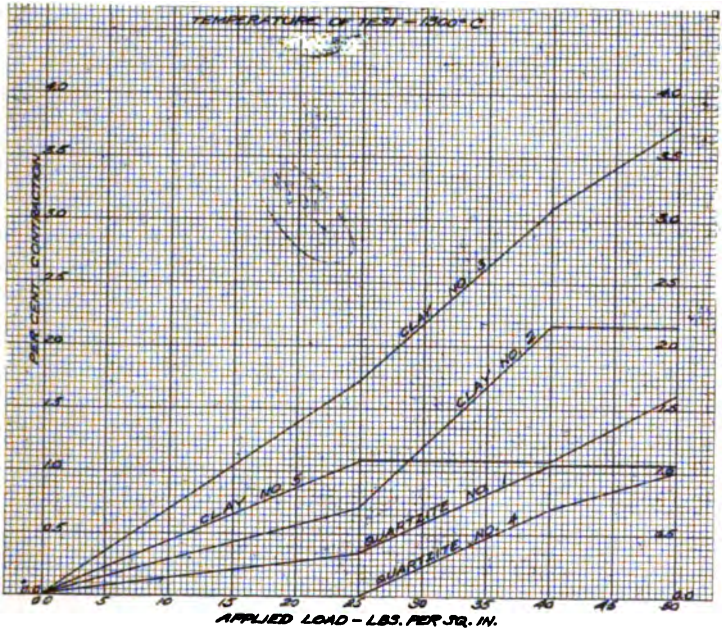


Fig. 6.—Deformation tests of firebrick.

Brand No. 3, however, is inferior in behavior and would perhaps not be considered a No. 1 material. The fact that contraction appears at this temperature even with loads as low as 25 pounds per square inch would seem to indicate that harder burning of the firebricks would improve them in this respect.

In Fig. 7 it is observed that at 2462° F. (1350° C.) the increase of deformation with pressure is very much more marked than at 2372° F. (1300° C.). The silicious clay bricks here are no longer differentiated from the high clay materials. The deficiency of No. 3 is brought out still more clearly. The important part of these results consists, of course, in the numerical results obtained. It is shown that it is impossible to expect clay materials to withstand load tests without showing any deformation whatever as is the case with silica brick, and hence, if the load test is to be used, the allowable deformation must be within reasonable limits. The load test, at 2462° F. (1350° C.) and with a pressure of 40 pounds per square

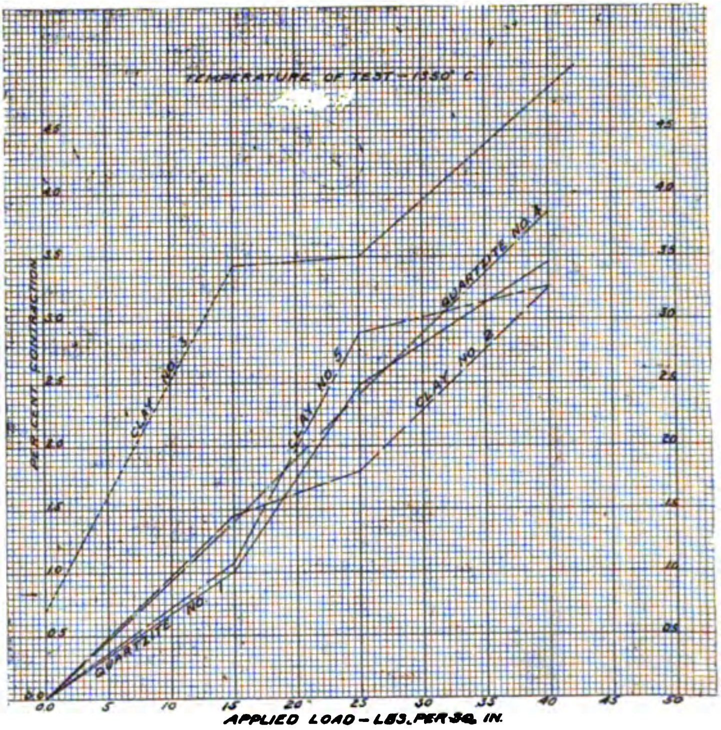


Fig. 7.—Deformation tests of firebrick.

inch, is undoubtedly to be preferred to higher pressures at lower temperatures. A deformation under the above conditions of not more than 4 per cent. linear contraction can therefore be reasonably expected for high class materials.

In connection with the above report the Committee wish to emphasize the following points:

1st. That between the temperatures of 2372° F. (1300° C.) and 2462° F. (1350° C.), clay refractories apparently undergo a pronounced change which manifests itself in a marked increase in their fluidity. Many clay refractories will stand up even under heavy loads at 2372° F. (1300° C.), but fail completely at 2462° F. (1350° C.) under much lighter loads, and only those of high refractoriness show contraction under 2½ per cent. at 25 pounds load.

2nd. That at 2462° F. (1350° C.) the contraction averages around 2.5 per cent. at 25 pounds load.

3rd. In the above tests and curves only the permanent expansion or contraction is shown; that is, the measurement is made after the brick under test has become cold. The thermal expansion—that is, expansion taking place during the heating up process—is not shown.

The analyses of the brick used in the above tests have not been completed as yet, but will be furnished later.

THE TESTING OF FIREBRICK UNDER THE CONDITIONS MET IN PRACTICE.

Report of Work Done by Mr. E. W. Desher Under Direction of Mr. W. H. Fulweiler of The United Gas Improvement Company.

Introductory: The apparatus is designed for use in testing samples of firebrick and other refractories under the conditions, as regards furnace temperature and load, met in actual practice. The data thus obtained show what may be expected of the material in the way of expansion or contraction upon heating, undue distortion or collapse under load, and general resistance to high temperature.

The work requires a furnace, beam for applying load, device for recording change in the shape of the brick, and Wanner pyrometer for reading temperatures. The bricks are placed in the funace, loaded to the desired point by weights at both ends of the beam, and gradually heated for about five hours. The recording device is connected to the beam and registers the expansion of the brick on a chart. After the temperatures are plotted on the same chart, the two curves—the time-temperature curve and time-expansion-contraction curve—graphically show the behavior of the brick. Additional information is obtained from a study of photographs of the brick before and after test.

Furnace: The furnace, Fig. 8, has an internal measurement of 18 inches x 18 inches x 18 inches and is built of firebrick resting on a solid foundation about 3 feet deep. Two refrax carborundum bricks, placed in the center flush with the floor of the furnace serve as a solid support for the bricks under examination. The cover is made in two sections, one of which is removed when the brick is set for test and both of which are cut out in the center to permit of application of the load.

The heating is done by six burners using gas and compressed air, the latter being preheated in its passage through a coil of pipe in the stack at the rear of the furnace. The burners are placed on the front and sides at two different levels and in such manner that the flames do not impinge upon the test brick.

Beam for Loading: This consists of a 5-inch I-beam with a plate and knife edge at the center where it rests upon the column of bricks in the furnace. At either end of the beam are supported the weights used to make up the ordinary loading. If the beam itself should give a load in excess of that desired, the counterbalance may be applied and the bricks required to sustain their own weight only.

At the center, extending upward, and rigidly connected to the beam, is a square iron bar which acts as a guide for the beam, operating against a set of four rollers at the top and

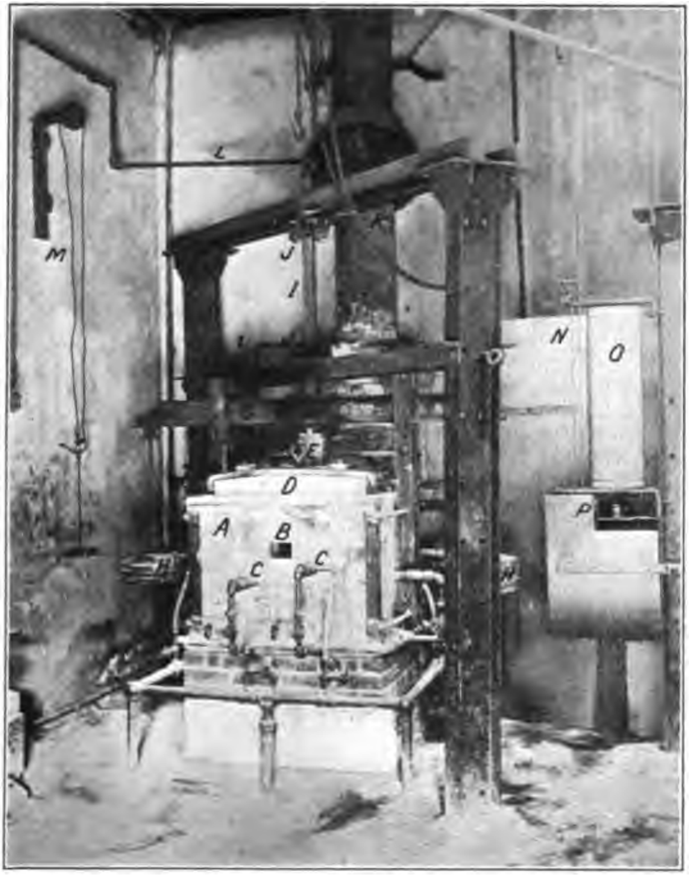


Fig. 8.—The United Gas Improvement Company test furnace.

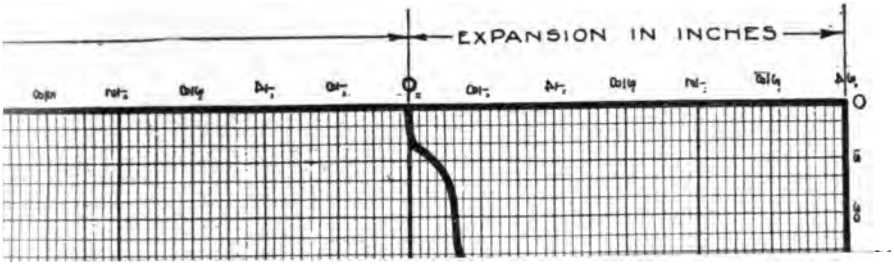
A —Furnace
B—Sight-hole.
C—Burners.
D—Removable lid.
E—Column of brick.
F—Knife-edge plate.
G—Beam.
H—Weights.
I—Guide bar.
J—Guide rollers.
K—Stack.
L—Compressed air line.
M—Counter balance.
N—Recording device.
O—Chart.
P—Clock.

four at the bottom. To further prevent the beam from turning in a horizontal plane, it is guided between finished surfaces of two upright angle irons at each end by rollers attached to the beam. It can thus be seen that the resistance to the up and down motion of the beam to conform with the expansion and contraction of the brick, has been reduced to a minimum.

Recording Device: The right end of the beam is connected to a rack, which drives a pinion; on the same shaft is a gear wheel. This gear wheel drives another rack to which a pencil is attached. As the ratio of gear is 6 to 1, it is seen that the expansion or contraction of the brick is multiplied six times as recorded by the pencil on the chart. The chart is attached to a cylindrical drum revolved by means of a clock. The moving parts of the device are counterbalanced in order to minimize the effect of inertia and fusion.

Method of Conducting Test: Two nine-inch brick are placed in the furnace, one upon the other, forming a column 18 inches high, which is just the inside height of the furnace. A refrax brick (Carborundum Co.) is placed on top of this column and occupies the space through the furnace lid and up to the knife edge on the beam, thereby protecting the latter from the high heat to which it would be subjected if in direct contact with the test bricks. The load is now applied by placing weights on ends of beam. The load used is either 10, 25, or 40 pounds per sq. in. according to the work for which the brick is intended.

After the chart is placed in position and the pencil set at zero, the furnace is lighted and the temperature gradually run up, slowly at first, and more quickly after the bricks show color. Temperature readings are taken at suitable intervals with a Wanner pyrometer, through an opening in the front of the furnace which is kept closed when observations are not being made. The rate of heating is adjusted so that the temperature will reach about 2700° F. in 5 hours. However, when the softening point of the brick has been reached, the temperature is kept constant, as nearly as possible, for about two


EXPANSION IN INCHES
0
0

hours. After the heating period the furnace is allowed to cool undisturbed for 24 hours. The bricks are now removed carefully, measured and photographed.

Conclusion: In making a record of the test, the chart is photographed, as the original is too large for convenience. A perusal of the sample tests attached hereto will show how readily the condition of the brick can be seen at any time during the test. Thus the maximum expansion is shown, and the temperatures between which the expansion for the greater part occurs are found on the time-temperature curve at points on the ordinates on which the expansion begins and that on which it ends. In similar manner the softening temperature of the brick is shown lying on the ordinate through the point where the brick starts to contract. The final set of the cooled bricks, 24 hours after the start of the test, is also shown.

The other photographs will give some idea of the appearance of the bricks before and after testing."

Discussion of Report and Description of Photos and Curves.

It is to be noted that the curves show not only the permanent expansion or contraction, that is, expansion or contraction due to chemical or physical change or both, but the thermal expansion as well.

Test No. 66, Fig. 9, made on silica brick under a load of 40 pounds per sq. in. These brick, Fig. 10, show a total expansion of ¼ inch or ⅛ inch per brick at a temperature of 2900° F. (1593° C.). The permanent expansion is 1/16 inch per brick or 7/10 of 1 per cent.

Test No. 80, Fig. 11, made on silica brick under a load of 40 pounds per sq. in. These brick, Fig. 12, show a total expansion of ⅝ inch or 5/16 inch per brick and a permanent expansion of 9/16 inch or 9/32 inch per brick, or 3.1 per cent. The maximum temperature was 2980° F. (1638° C.). The behavior of this brick is peculiar in that at a temperature of about 2700° F. (1482° C.) the brick shows a marked increase in expansion which continues up to 2900° F. (1593° C.) when the curve again flattens out, indicating that the brick was not

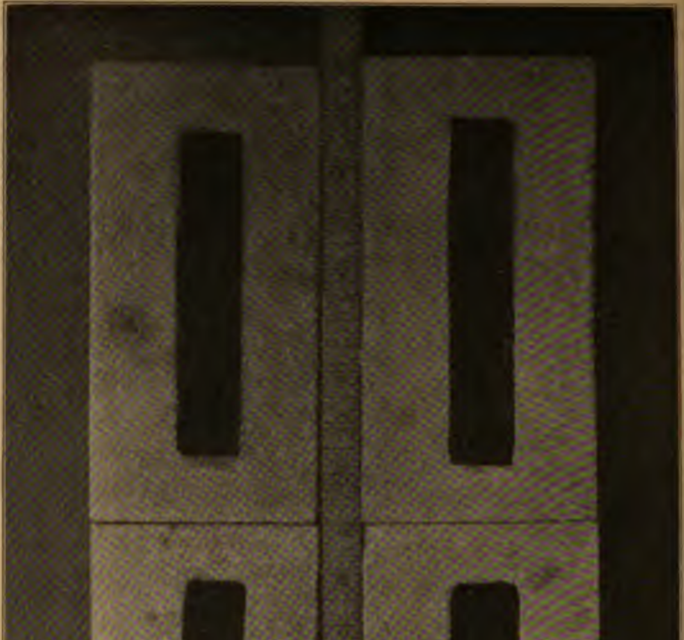
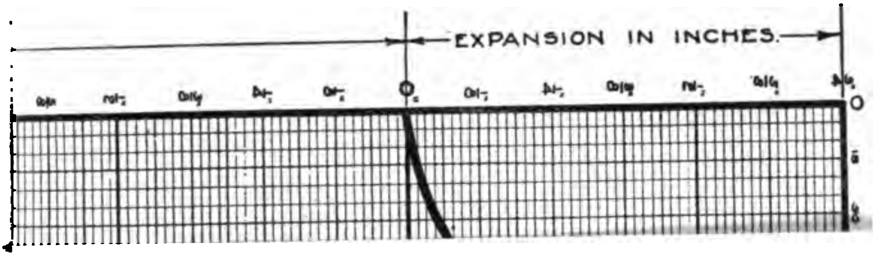


Fig. 10.—Bricks used in test No. 66.


EXPANSION IN INCHES.
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burned at a sufficiently high temperature in the kiln. In connection with the permanent expansion of silica material, the Committee has insufficient information regarding the action of this material when heated to temperatures below the burning temperature. This subject, both as regards the effect of temperature and time of temperature maintenance, will be further investigated.

Test No. 64, Fig. 13, was made on a high grade "flint clay" brick. These brick, Fig. 14, contained between 55 and 60 per cent. silica and 35 to 40 per cent. alumina. The brick maintains its shape fairly well, but shows excesive contraction under the load of 40 pounds per square inch. This contraction begins at about 2300° F. (1260° C.). In this case the temperature was carried on up to 2660° F. (1460° C.) and the permanent contraction amounts to almost 1 inch per brick, or 11 per cent.

Test No. 69, Fig. 15, was a supposedly high refractory brick containing a high percentage of alumina. Its behavior is very similar to test No. 64, Fig. 13. It begins to contract at about 2300° F. (1260° C.), and shows excessive permanent contraction (see Fig. 16). In this case also the temperature was carried up to about 2680° F. (1471° C.) and was not stopped and maintained at the point where contraction started.

Test No. 70, Fig. 17, made on clay brick under a load of 40 pounds per sq. in. These brick, Fig. 18, show a total expansion of 1/8 inch; begin to contract at 2460° F. (1349° C.) and show a permanent contraction of 5/16 inch or 5/32 inch per brick after being heated to a maximum temperature of 2570° F. (1410° C.). The permanent contraction in per cent. is 1¾. This brick contains as much as 75 per cent. silica in its natural state.

Test No. 71, Fig. 19, was made on a high grade German brick. The analysis of this brick shows a very high percentage of alumina. Contraction in this case began at about 2500° F. (1371° C.), (see Fig. 20), and this temperature was maintained for about two hours. The brick kept their shape well

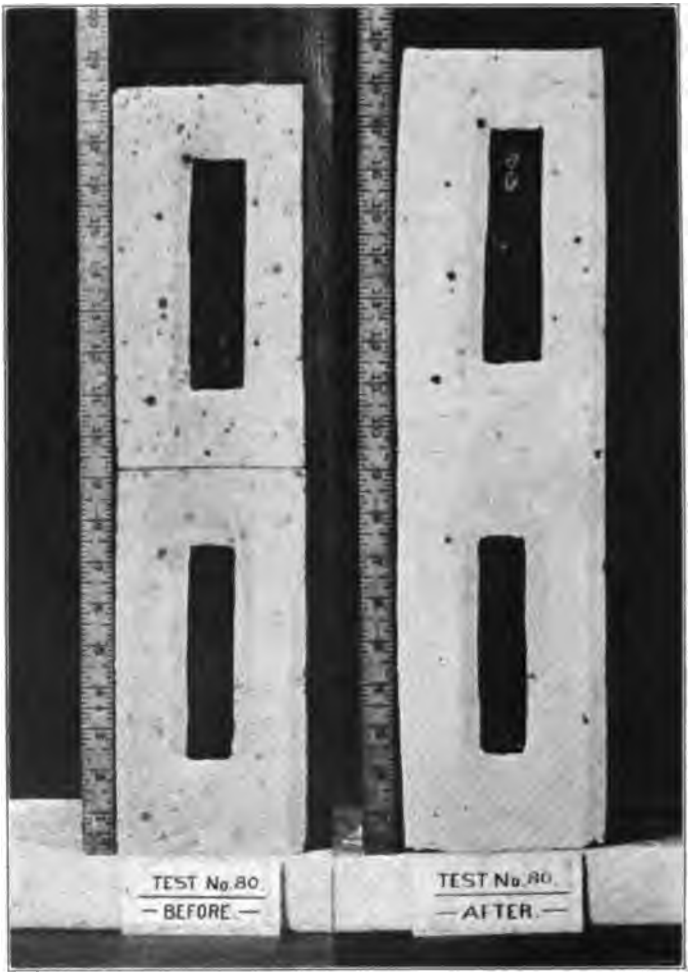
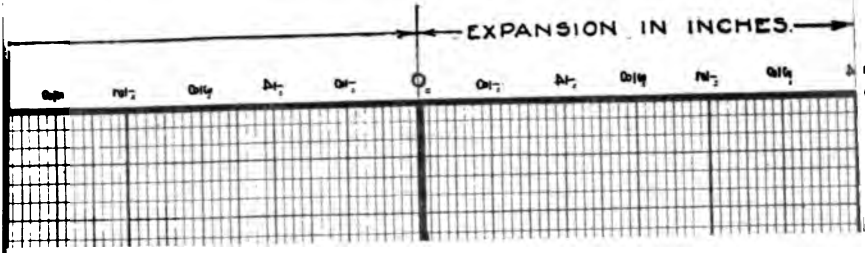


Fig. 12.—Bricks used in test No. 80.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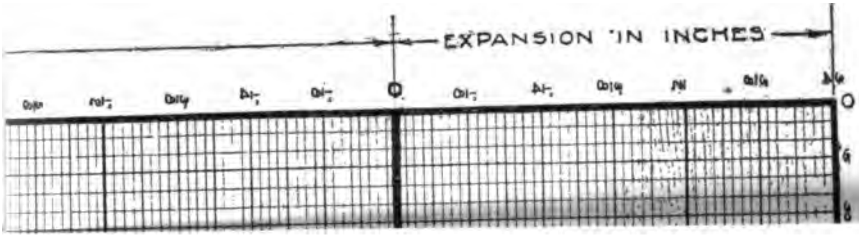
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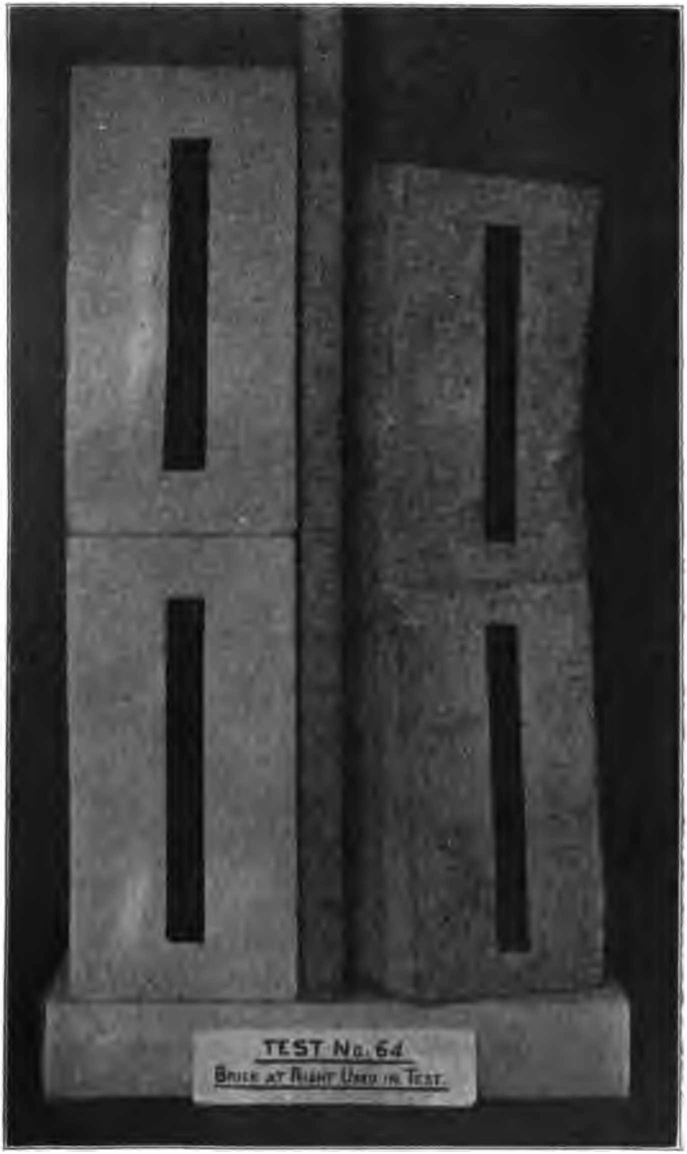


Fig. 14.—Bricks used in test No. 64.

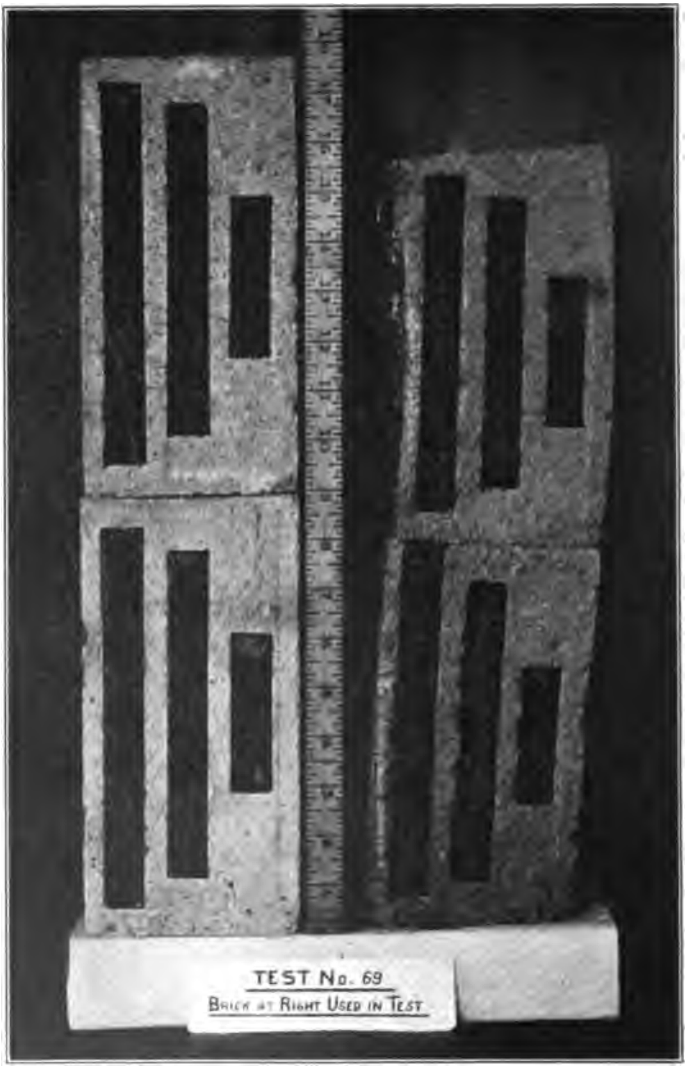
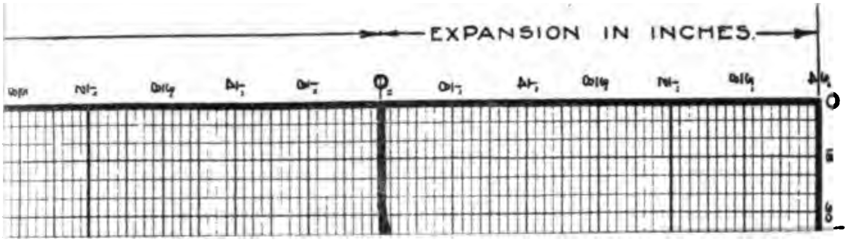


Fig. 16.—Bricks used in test No. 69.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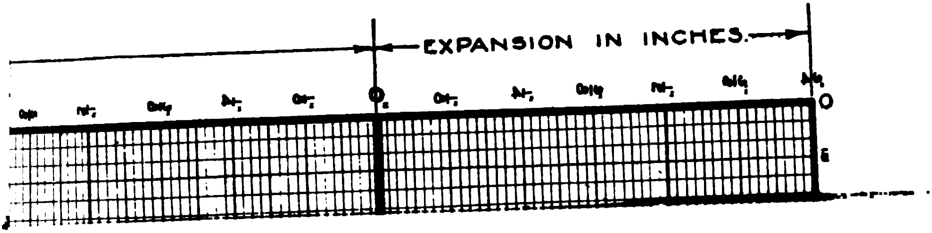
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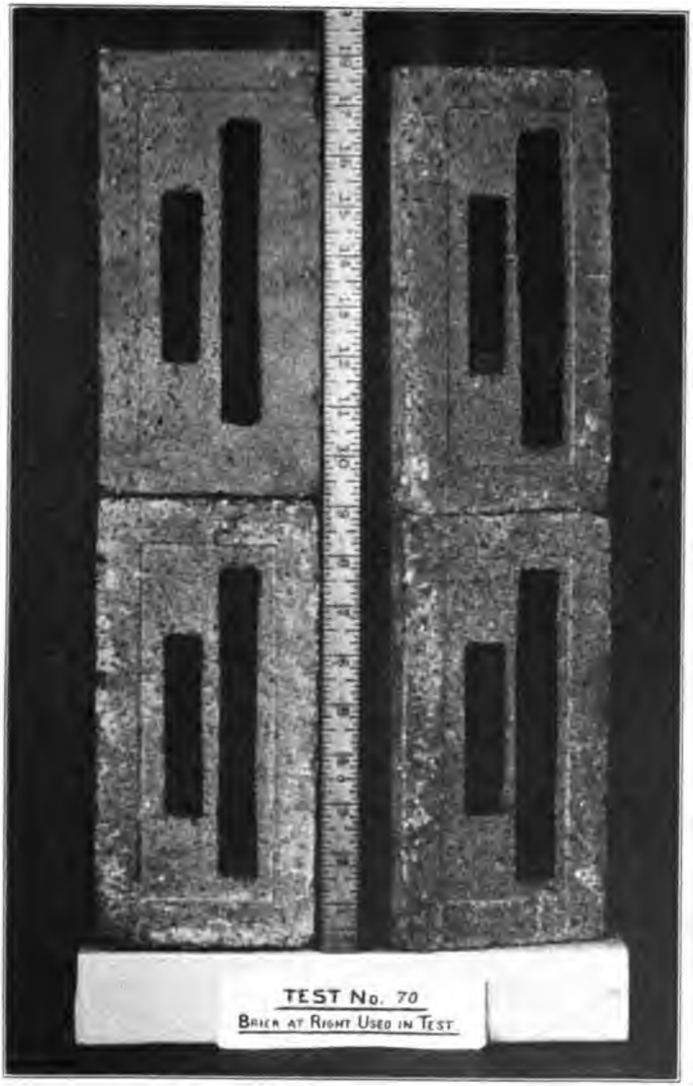


Fig. 18.—Bricks used in test No. 70.

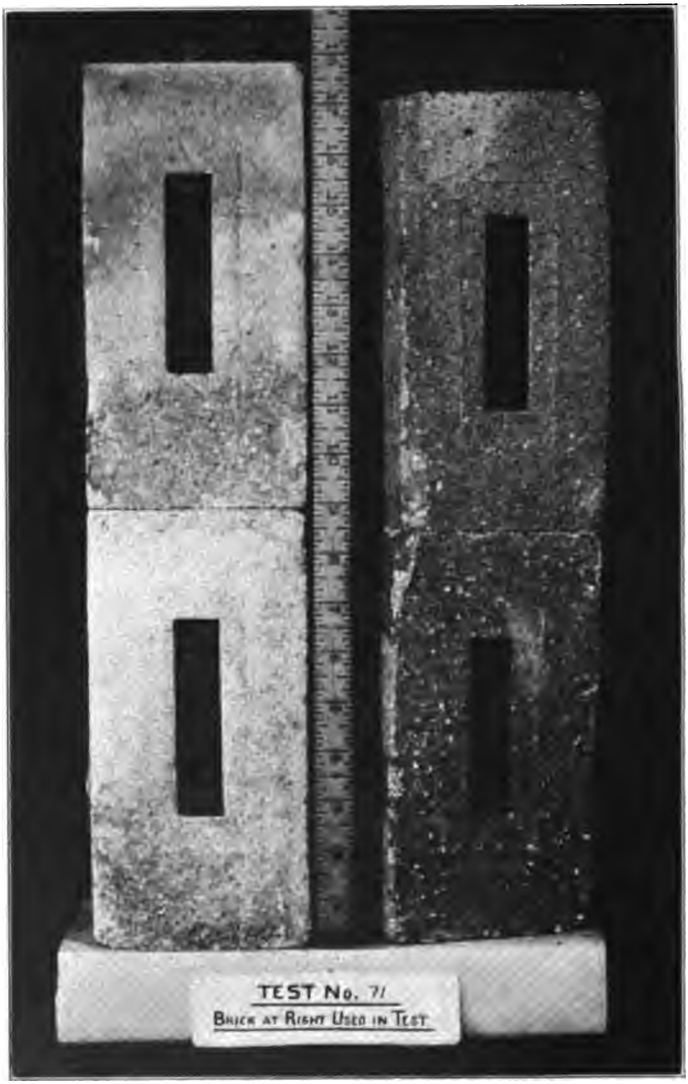
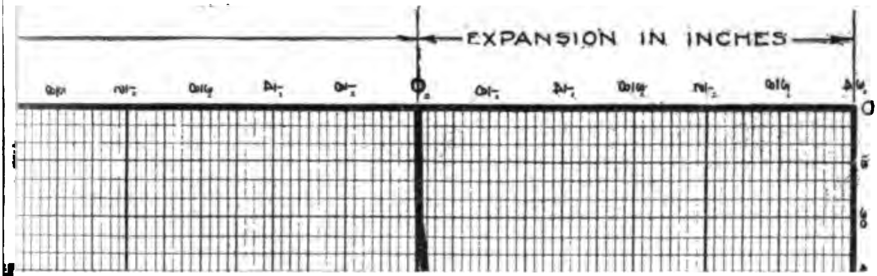


Fig. 20.—Bricks used in test No. 71.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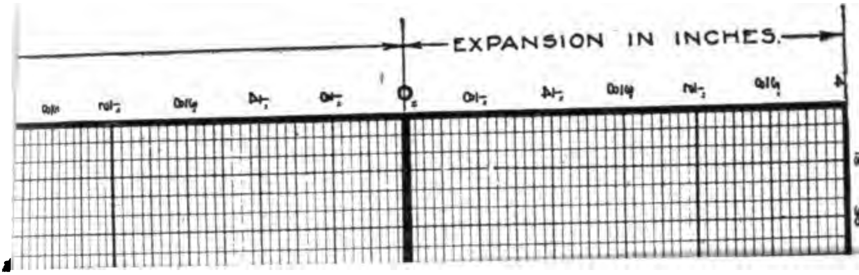
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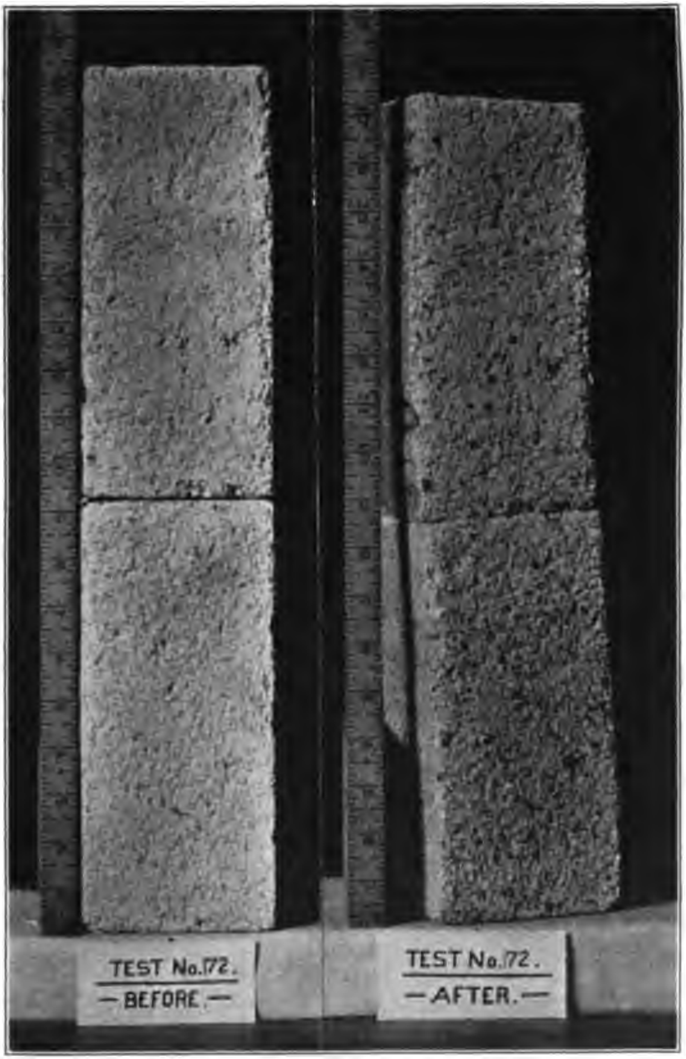


Fig. 22.—Bricks used in test No. 72.

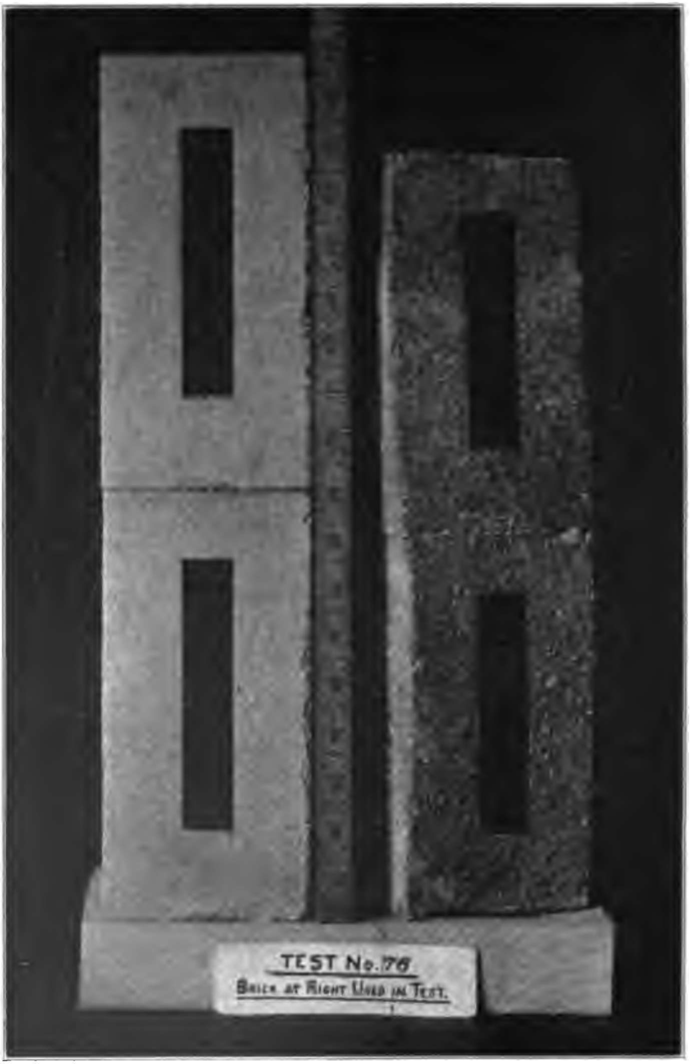
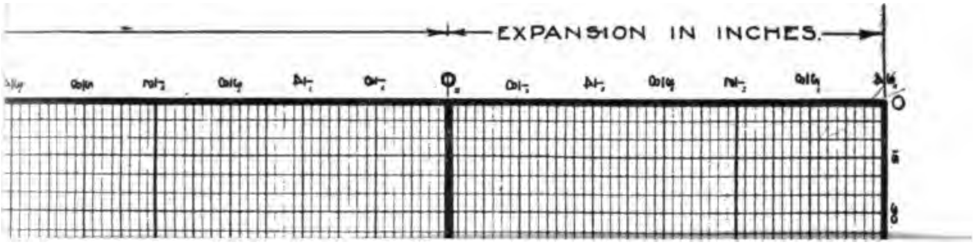


Fig. 24.—Bricks used in test No. 76.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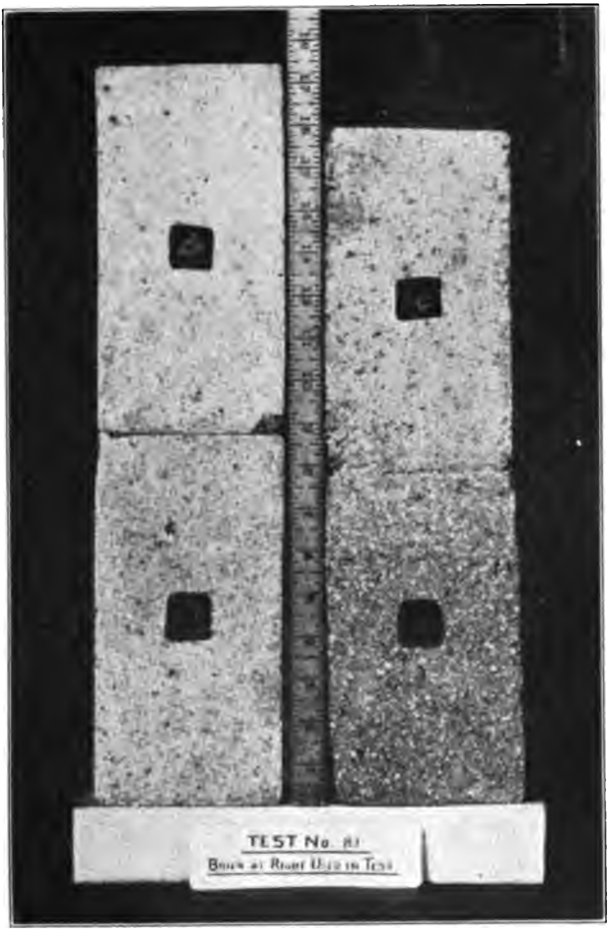


Fig. 26.—Bricks used in test No. 81.

and showed a permanent contraction of 11/32 inch per brick or 3.4 per cent.

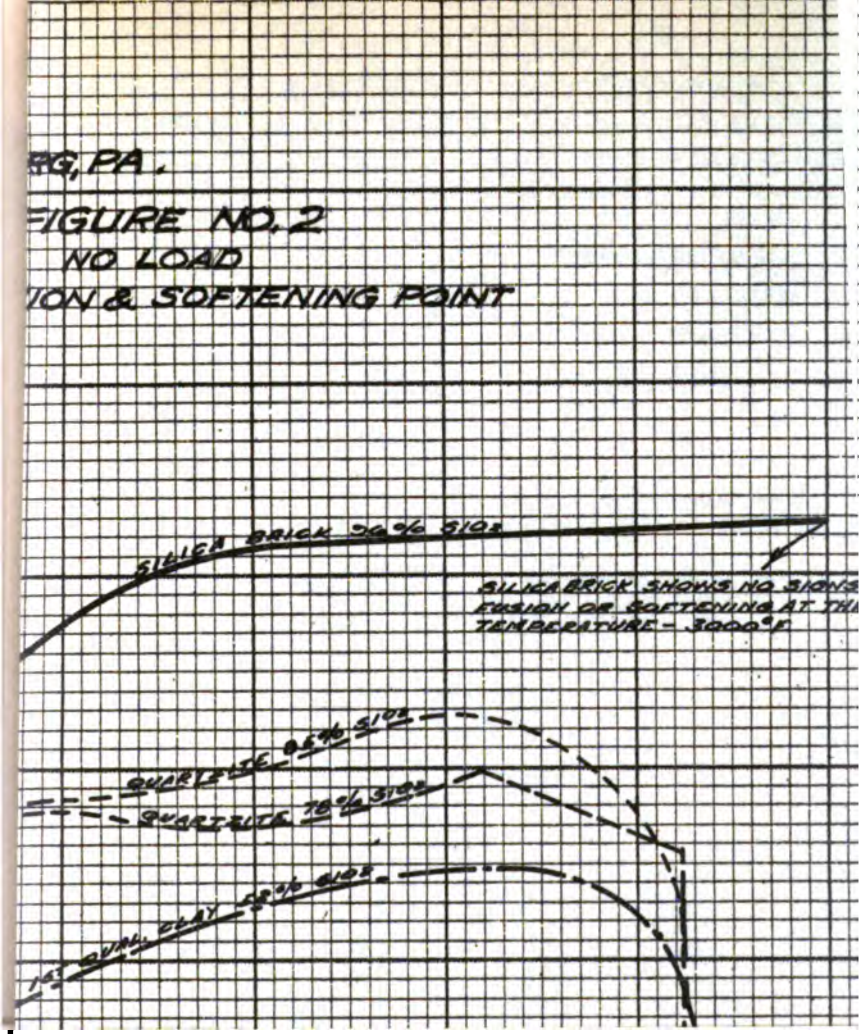
Test No. 72, Fig. 21. This also was a German brick containing a high per cent. of alumina, and was of very coarse texture. The brick, Fig. 22, analyzed about the same as test No. 71, Fig. 19. In this case contraction began at about 2340° F. (1282° C.). This temperature was maintained for about two hours. The brick show a contraction at this temperature of about ½ inch per brick, or 5.5 per cent.

Test No. 76, Fig. 23, was made on a flint clay brick similar in analysis to test No. 64, Fig. 13. It was submitted as a cheaper brick than that in test No. 64, and came from the same yard. Contraction began at about 2180° F. (1193° C.). The temperature in this case was also carried on up to about 2570° F. (1410° C.) and the brick, Fig. 24, shows excessive permanent contraction amounting to over 1 inch per brick.

Test No. 81, Fig. 25, made on a flint clay brick under a load of 40 pounds per sq. in. These brick, Fig. 26, show a total expansion up to 2340° F. (1282° C.) of about 1/16 inch. They then begin to contract, and contract rapidly at a temperature of 2420° F. (1327° C.) showing a permanent contraction of 1½ inch or ¾ inch per brick, or 8⅓ per cent.

It is to be noted that in Tests 64, 69 and 76 (Figs. 13, 15 and 23) the temperature was not stopped and maintained at the point where contraction began but was carried on considerably higher. In the other tests the temperature was maintained constant at about the point where contraction began and therefore shows the contraction of the brick at this so to speak "critical point."

In this connection further tests made on clay brick under a load of 20 pounds per sq. in. have come to the attention of the Committee showing a contraction starting at a lower and stopping at a higher temperature. This suggests that probably bricks showing this peculiarity are under-burned relative to the test temperature and load. This subject will be further investigated by the Committees.


RG, PA.
FIGURE NO. 2
NO LOAD
ION & SOFTENING POINT
SILICA BRICK 96% SiO2
SILICA BRICK SHOWS NO SIGNS
FUSION OR SOFTENING AT TH
TEMPERATURE - 3000°F
QUARTZITE 95% SiO2
QUARTZITE 78% SiO2
1ST QUAL. CLAY 52% SiO2

REPORT OF TESTS MADE BY THE HARBISON-WALKER REFRACTORIES COMPANY. PLATE I—FIGS. 1 AND 2.

The curves shown in Plate I show the behavior of representative samples of fireclay, silica and quartzite material under gradually increasing temperatures. The tests were made on 9 inch x 9 inch piers approximately 12 inches in height, laid with standard 9-inch brick dry rubbed to contact surfaces. The heat was brought up at a rate of 50° F. (28° C.) per hour, and the observations taken at levels on a rod extending through the top of the kiln and reaching the brick. It was also afterwards checked by accurate measurements taken at the four corners of the pier. Temperatures for the curves were determined by means of Leger-Orton cones, and the table of temperatures used was that of Orton's as published by him.

Fig. 1 on this plate shows the behavior of these materials under load. The silica brick pier, analyzing approximately 96 per cent SiO_2, was subjected to a load of 78 pounds per sq. in. and showed no settling or sign of fusion at 3200° F. (1760° C.). It is to be noted that nearly all of the expansion takes place between 0° F. and 1000° F. (538° C.), and is practically uniform in this range. The quartzite pier, analyzing 78 per cent SiO_2, subjected to a load of 27 pounds per sq. in., shows expansion up to about 2000° F. (1093° C.), then begins to soften and contract, and at 2500° F. (1371° C.) has contracted very much and lost shape. The fireclay pier, analyzing 52 per cent. SiO_2, subjected to a load of 27 pounds per sq. in., shows expansion up to about 2000° F. (1093° C.), then contracts slowly up to about 2500° F. (1371° C.), then more rapidly, and at 3000° F. (1649° C.) had lost its shape.

Fig. 2 on this plate shows the expansion and softening point of samples of silica brick 96 per cent. SiO_2, quartzite brick 85 per cent. SiO_2, quartzite brick, 78 per cent. SiO_2, and fireclay brick 52 per cent. SiO_2. The piers in these tests were not subjected to any load other than their own weight. The silica brick show no signs of fusion at 3000° F. (1649° C.); the 85 per cent. quartzite brick and the 78 per cent. quartzite brick both softened and fused at about 2700° F. (1482° C.) so that further measurements were impossible. The fireclay brick expanded up to about 2500° F. (1371° C.), then contracted rapidly up to 3000° F. (1649° C.), but was in good condition as regards fusion at 3000° F. (1649° C.).

The curves, Figs. 1 and 2, on this plate, show that the expansion increases as the silica content of the brick increases, the maximum for the clay brick being a little over 1/16 inch per foot; in the quartzite about ⅛ inch per foot, and in the silica about 3/16 inch per foot. With the silica and quartzite brick most of this expansion takes place before 1000° F. (538° C.). The tests also show clearly the very great difference in the behavior of fireclay material under load and at no load. A loading of 25 pounds per sq. in. will make a difference of 400 to 500° F. (204 to 260° C.) in the temperature to which the material may safely be subjected.

INVESTIGATIONS OF DR. A. V. BLEININGER AND MR. BROWN OF THE BUREAU OF STANDARDS.

These gentlemen have made exhaustive investigations of the subject of clay refractories, and the results of their work are published in Technologic Paper No. 7 of the Bureau of Standards, entitled "The Testing of Clay Refractories, with Special Reference to their Load Carrying Capacity at Furnace Temperatures," and in a reprint from the Proceedings of the American Society for Testing Materials, entitled "Testing of Refractories." Your Committee wishes to emphasize the value of this work and strongly urges all those interested in the manufacture, sale or use of refractory material to secure and study these reports. The results of their work and the assistance given by Dr. Bleininger as a member of the Committee have been of the greatest help to your Committee, and have saved an immense amount of preliminary test work.

Other Work of the Committees.

In addition to the work of preparing the specifications and the investigations and experimental work in connection therewith, the Committees are co-operating with the American Society for Testing Materials in the preparation of standard methods of test covering the various qualities possessed by refractory materials for which it seems desirable to have standard test methods. This work gives promise of being brought to a successful conclusion this year. An interesting investigation of the behavior of silica brick under sudden temperature changes is also being conducted at the request of the Committees by the Solvay Process Company under the direction of Mr. W. H. Blauvelt. This work when completed promises to be of greatest interest and value to all manufacturers and users of silica material.

Central Testing Laboratory.

The load tests called for in the specifications require a rather heavy expenditure, a well equipped laboratory, and a competent working staff. This is impractical except for the very largest companies. The Bureau of Standards is engaged primarily in research work and are not in a position to undertake routine testing. If the specifications and tests as worked out are to be of any assistance to the gas fraternity as a whole, a suitable place must be provided where the testing work can be done. It is possible that some of the larger companies or some of the commercial testing laboratories, or even the refractory manufacturers, might be willing to undertake this work, but at best such arrangements would not be entirely satisfactory. Your Committee feels that work of this nature should be done in a central testing laboratory, conducted by and for the makers, builders and users of material used in gas manufacture.

We would respectfully refer this matter to the careful consideration of the Board of Directors of the Institute, and of the members of the Refractories Manufacturers Association.

Herman Russell, *Chairman,*
J. W. Batten,
W. H. Blauvelt,
J. S. DeHart,
W. H. Fulweiler,
J. P. Kennedy,
C. J. Ramsburg,
J. H. Taussig,
H. L. Underhill.

Mr. G. A. Balz (Perth Amboy, N. J.): (Written discussion communicated.) I wish to state that in my opinion a very decided forward step has been taken toward promoting a better understanding than has heretofore existed between the manufacturer and user of refractory materials.

I am grateful for the peculiar advantage which has enabled me to consider the report from three distinct, yet intimately related, points of view; the first being as a manufacturer of refractories; the second as a user, in the sense of being associated with a concern which constructs furnaces in which refractory materials represent a factor of primary importance; and third as an operator in observing the characteristics and performance of refractory materials in actual use.

As a manufacturer, I believe that the report of the Joint Committee, even though their work as therein represented is a relatively small fraction of the ultimate scope of their investigation into the points of interest to the gas industry, has enabled our industry generally to determine where improvement of its product is possible and necessary. I believe that the day of manufacturing refractories along certain narrow lines, which have been followed closely by many of us for a good many years, is rapidly passing, and that the necessity of scientific investigation, to assure a proper and uniform quality for specific requirements, will shortly be recognized. When such has become a fact, I have no doubt that the refractory industry, which forms a most important part of the entire industrial fabric of our country, will be elevated from the rut in which it has traveled for a considerable number of years.

As a user of refractories, I wish to congratulate your Committee upon the manner in which the requirements of the various materials have been stated and presented to the manufacturers. I fully appreciate the tendency of modern gas engineering practice to employ high temperatures for obvious reasons of economy, and the defects which some of the aluminous refractories have developed under these conditions. Consequently, the ultimate results of a better understanding of practical requirements by the manufacturers will tend to minimize, and I believe in time entirely remove, the controversies which have too frequently developed in the past from improper performance of refractories under actual service conditions. If your Committee's report does nothing more than accomplish this, its work surely has not been in vain.

Limitations have naturally been placed both upon the manufacturer and user of refractories beyond which the manufacturers cannot go in meeting the demands of the user, and beyond which the user cannot set his specification. In my opinion, these limitations have been brought out in your report, although in the future work of the Committee I would caution against any tendency to under-estimate the limitations of raw materials and physical structure to which a manufacturer is subjected in his efforts to meet the requirements of the user.

In conclusion, I wish to acknowledge, as a member of the Manufacturers Committee, the fair spirit exhibited by your Committee in amalgamating the limitations which I have mentioned, and I trust that the work, which has been so auspiciously begun, will be continued until the entire field of requirements of refractory materials for your industry has been analyzed.

MR. J. S. DEHART, JR. (Newark, N. J.): (Written discussion communicated.) I feel that a word of praise rather than criticism is due our worthy Chairman for the initiative he has shown in directing the work during the last two years, and his patient consideration of its members to bring a united action on a subject which, at the beginning, was in rather a chaotic condition.

In think few of us realized the problem which confronted the manufacturer, the designer and user of refractory materials for gas benches, until they were all brought together in one committee.

It soon became apparent that designers of gas benches were asking operators to use apparatus with practically no factor of safety; that expensive materials were often used where a less expensive grade would be satisfactory; that the melting point of materials was often considered the vital factor, when shrinkage or expansion was the cause of the failure.

In connection with the permanent swelling and shrinkage of fireclay and silica material, it would be well to bear in mind that the permanent shrinkage of fireclay material is more dependent upon the element of time than is the case with silica material. It is difficult to determine this factor in a laboratory test, but in actual practice the element of time enters very seriously into one's calculations in estimating the life of a setting.

MR. J. P. KENNEDY (East Cambridge, Mass.): (Written discussion communicated.) From the standpoint of the user of firebrick and silica material there is undoubtedly great need for the standardization of grades, etc., of such material.

At the plant with which I am connected we are just now experiencing such a need. In benches of fireclay material built in separate years and of ostensibly the same grade of material, and with the material carrying the same load in all cases, there is a very marked difference in the character of the material used in these benches, as evidenced by the rapid settlement in some, and none in other benches adjoining and operated under practically the same conditions. Close adherence to the specifications suggested by the committees will, I believe, be of assistance to both the manufacturer and the buyer in getting a more uniform product for the work to be done.

Table A of the other report contains the basis of valuable information which it is necessary to have in order to fairly question the need for fireclay versus silica and yet 61 per cent. of the companies listed, give no data with regard to the loads carried at the maximum temperature points. The probability of these temperatures being at times from 250 to 500 degrees higher than stated, indicates the possibility of many failures of material being due to imposing a duty too great for the material selected rather than from bad usage of the material by the operator. The specifications for fireclay and silica material seem to me to be reasonable ones, and broad enough to meet the average construction design, and if used, in connection with exact knowledge of the requirements for temperature and loads to be carried, a uniformly satisfactory material should be procurable. However, without some central testing stations to carry out the tests called for by the specifications, the object of the specifications must be somewhat questionable. Large companies, of course, can maintain their own testing machines while smaller ones cannot.

The Bureau of Standards in its tests brings out what to me is an important point with regard to the resistance to crushing which fireclay brick may have. In the tests attention is directed to the part played by the degree of compactness of the structure of the brick. It seems to me that in the fineness of the grind combined with the longer period of burning at the high temperatures may lay the success of some fireclay material when used under loads and temperatures seemingly suited only for the highest grades of silica material.

The chemical analysis of each kind of brick whose test is recorded in the report of the Committee should be given if the full benefits of these tests are to be obtained. Especially is this so in the case of the Bureau of Standards' No. 7 test as exhibited in Table I, which, as the Bureau report says, is both suggestive and indicative of higher possibilities for fireclay brick. I am, personally, not a convert to the uses of silica for general bench work provided the proper fireclay material can be produced to meet the demands, and the Committee's report seems to indicate in several test results that such may be expected.

The field covered by the report is so broad and so suggestive that I feel that my present criticism can be of little value. The principal value of the report, I think, is in the demonstration for the need of further and continuous study, which should in time results in saving considerable sums of money to both the user and manufacturer of refractory material.

THE PRESIDENT: The next is the report of the Representatives on Joint National Committee on Electrolysis.

REPORT OF THE REPRESENTATIVES ON JOINT NATIONAL COMMITTEE ON ELECTROLYSIS.

The Committee on Electrolysis can report only progress, as the Publication Committee of the Joint National Committee on Electrolysis, mentioned in the May Number of the *News*, has not finished its work, although its Chairman reports that considerable progress has been made, and hopes all the subcommittees' reports will be received before October 1st.

Your Committee regrets that its final report must be delayed another year.

J. A. GOULD, *Chairman,*
A. F. GANZ,
J. D. VON MAUR.

THE PRESIDENT: The next is the report of the Committee on Supplying Large Buildings with Gas.

REPORT OF THE COMMITTEE ON SUPPLYING LARGE BUILDINGS WITH GAS.

The work of the Committee on Supplying Large Buildings with Gas, as defined at the time of its appointment, was to prepare in form suitable for distribution to architects, builders, etc., the data and material presented in the report of the Committee on Piping Large Buildings for Gas which was submitted to the Institute at its meeting in 1914. Subsequent developments indicated that it was not desirable to attempt to complete our report this year, but to prepare a synopsis and table of contents, and, in the event of their being approved, to proceed to get the work in shape for publication about the end of next year. To this end, the Committee has solicited suggestions and advice from various sources as to how much of the material appearing in the report of the Committee on Piping Large Buildings for Gas might properly be included in a publication of the sort proposed; what sections would seem to have the greatest value for the purpose; what additional material would seem desirable in order to cover any matters that may not have been sufficiently discussed in the original report, etc.

Based largely upon the suggestions and criticisms received, the table of contents and synopsis presented herewith have been prepared. Those sections of the report of the Committee on Piping Large Buildings for Gas, which appear to be of importance have been included; other material and data that is believed to be of particular interest and value to the architect and builder have been added.

It is proposed that the report in its final shape will take the form of a data book containing information on the subject of Supplying Large Buildings with Gas. It is the belief of your Committee that such a data book, rather than a general treatise on the subject, will be more accessible for the information desired, and will prove valuable as a reference book to architects and builders in general.

It is the purpose of the Committee to include throughout the text of the data book, photographs of prominent New York City buildings and prominent buildings in other parts of the United States which are piped for gas. Each photograph will bear the name of the architect, and a short statement of the uses to which gas is put in that building, together with the cubic feet consumption per year. Other interesting photographs of gas appliances and installations will be continued in an appendix.

The synopsis refers to certain sections and paragraphs contained in the report of the Committee on Piping Large Buildings for Gas, pages 1338-1490, PROCEEDINGS of the American Gas Institute, Vol. IX, 1914, Part II. These references, it is believed, will be valuable in preparing the final report of the present Committee. It is not intended necessarily to include the extracts verbatim, for in all probability it will be advisable to condense the information, to re-arrange some parts of it in tabular form, to make certain additions and to supplement the illustrations, especially the fixture illustrations, with illustrations of more recent developments. Furthermore, it does not appear advisable to use all the appliance installation illustrations, and in place of some of the illustrations, domestic appliances will be shown.

It is the hope of the Committee that the members of the Institute will freely criticise the outline of the proposed report so that the Committee may have the benefit of such criticisms.

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    3. Fuel appliances.
    4. Power appliances.

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    - 4. Power appliances.

V. GAS AS AN ILLUMINANT.

- (*a*) 1. Advantages.
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    - 1. Reliability.
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    - 4. Convenience.
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VII. GAS AS A SOURCE OF POWER.
  (*a*) Advantages and scope of field.
  (*b*) Considerations governing choice of power unit.
  (*c*) Horse-power required for various classes of service.
  (*d*) Cost comparison—Gas *vs.* Electricity.

VIII. GAS PIPING.
  (*a*) Piping at time of erection.
  (*b*) Cost of piping at time of erection.
  (*c*) Cost of piping after erection.
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APPENDIX.

"SECTION A"—FIXTURE ILLUSTRATIONS.

"SECTION B"—LIGHTING INSTALLATION ILLUSTRATIONS.

"SECTION C"—APPLIANCE ILLUSTRATIONS.

SYNOPSIS OF REPORT.

I. INTRODUCTION.
  (*a*) Ist paragraph of "Report of Committee on Piping Large Buildings for Gas"—pages 1338 and 1339 of 1914 PROCEEDINGS of the American Gas Institute, Vol. IX, Part II.
  (*b*) Statement that the local gas company will be glad to furnish information, particulars, etc., to architects, builders and owners, at their request.

II. GAS SERVICE.
  (*a*) Introductory paragraphs 1 and 2 under "Gas Service" on pages 1342 and 1343.
  (*b*) Reliability of supply, beginning last paragraph on page 1343, and continuing on page 1344 to beginning of last paragraph.
  (*c*) Quantity of supply--paragraphs 2 and 3 on page 1343.
  (*d*) Quality of supply—beginning last paragraph on page 1344, and continuing to bottom of page 1346,—omitting last two sentences of paragraph 1, page 1346, "In Appendix 'Section A.' . . . etc."

III. WHY BUILDINGS SHOULD BE PIPED FOR GAS.
  (*a*) Last paragraph on page 1347, and continuing to middle of page 1348.
  (*b*) From 2nd paragraph, middle page 1348, to end of 1st paragraph on page 1349—omitting last eight words of paragraph, namely, "of which the following are taken as examples."

(*c*) From beginning of 2nd paragraph on page 1349, to "Gas as an Illuminant" on page 1350.

IV. USES OF GAS.

(*a*) In the Home.

1. Introductory paragraph showing convenience, economy, etc., of gas appliances.
2. Light—taking up appliances. Tabulation.
3. Fuel—taking up appliances. Tabulation.
4. Power—taking up appliances. Tabulation.

(*b*) In the Industries.

1. Introductory paragraph.
2. Light—taking up appliances. Tabulation.
3. Fuel—taking up appliances. Tabulation.
4. Power—taking up appliances. Tabulation.

V. GAS AS AN ILLUMINANT.

(*a*) Advantages, artistic considerations, improvements in appearance, efficiency, reliability, etc. From "Gas as an Illuminant" on page 1350, to end of 2nd paragraph on page 1351, changing Section "B" and "C" on the 7th line, page 1351, to Section "A" and "B" respectively.

(*b*) Flexibility. Taking up various sizes of units with tabulations. From beginning of 3rd paragraph, page 1351, to beginning of last paragraph on page 1352.

(*c*) Control.

From beginning of last paragraph on page 1352, to end of 2nd paragraph on page 1353.

Table showing pilot light consumption.

(*d*) Hygienic value.

1. Quality of light.
   Beginning last paragraph on page 1353, to end of 3rd paragraph from bottom of page 1354.
2. Safety.
   Second paragraph from bottom of page 1354.
3. Effect on Atmosphere.
   From beginning of last paragraph on page 1354, to "Gas as a Fuel," on page 1358, omitting 2nd paragraph, page 1355, and 2nd paragraph on page 1358.
   Table showing relative radiation from gas and electricity (reference, p. 729, Vol. V, *Transactions* Illuminating Engineering Society, November, 1910).
4. Charts showing average relative cost between gas and electricity, including and excluding maintenance.

VI. GAS AS A FUEL.
- (*a*) Introductory paragraph.
  First paragraph under "Gas as a Fuel" on pages 1358 and 1359.
- (*b*) Advantages.
  Beginning 2nd paragraph on page 1359, and continuing to end of 1st paragraph on page 1360.
  From last paragraph, page 1362, to "Gas as a Source of Power," page 1364.
  Second paragraph, page 1360, changing Section "F" to read Section "C."
  Continuing beginning of 3rd paragraph, page 1360, to beginning of last paragraph on page 1362.

VII. GAS AS A SOURCE OF POWER.
- (*a*) Advantages and scope of field.
  To include paragraph under "Gas as a Source of Power" on page 1364.
- (*b*) Considerations governing choice of power unit.
- (*c*) Horse-power required for different classes of service.
- (*d*) Comparative monthly costs—Gas Engine *vs.* Electric Motor.

VIII. GAS PIPING.
- (*a*) Necessity of piping buildings for gas at time of erection.
  From "Piping after Erection" on page 1365, to "Piping Necessary" on page 1366.
- (*b*) Cost of Piping Buildings for Gas at Time of Erection.
  To include material under "Cost of Piping" on pages 1367-1369, omitting last paragraph at end of above section.
- (*c*) Piping after erection.
  Table citing cost data with examples of buildings piped after erection.
- (*d*) Representative Piping Layout.
- (*e*) Standard piping specifications, covering General House Piping (from Report of Committee on "House Piping" A. G. I.).

APPENDIX.

SECTION "A":
Fixture illustrations.

SECTION "B":
Lighting installation illustrations.

SECTION "C":

Appliance illustrations, including gas fireplace heaters, grates, logs, model kitchens, ranges, hot plates, hotel appliances, heaters, mangles, bathroom appliances, chafing dishes, sterilizers, incinerators, vacuum cleaners, etc.

NOTE.—In the final preparation of the pamphlet, interesting photographs should be included with the text throughout, including prominent New York buildings and Government buildings elsewhere in the United States, piped for gas. Each photograph should bear a statement of the architect's and engineer's name, the number of users of gas, and the yearly consumption of building.

O. H. FOGG, *Chairman,*
ALONZO P. EWING,
D. E. KEPPELMANN,
J. S. MCILHENNY,
C. E. REINICKER,
W. J. SERRILL,
J. D. VON MAUR,
R. C. WARE,

MR. WALTON FORSTALL (Philadelphia): (Written discussion communicated.) The data and reference book proposed by this Committee should close the subject for a time, after there has been included in it standard specifications for house-piping, whenever these may be adopted by the Institute. From time to time, however, it will undoubtedly be necessary to revise this book to keep in touch with the art of gas supply, and this would presumably require a lookout committee, somewhat similar to that of the Committee on Pipe Standards.

MR. C. M. COHN (Baltimore): (Written discussion communicated.) The reference book, which has been planned by the American Gas Institute through the Committee on Supplying Large Buildings with Gas and which is to be distributed among architects, builders and others, should prove of benefit to the gas industry and of great service to the persons receiving copies, providing the book is compiled in a comprehensive, concise, and interesting manner, and will contain only such information as will make it of real value to interests other than those of the gas industry.

The title, "Supplying Large Buildings with Gas" does not cover the subject matter of the entire book, as the information suggested by the Committee treats of subjects other than that of merely supplying buildings with gas; it mentions the various uses and equipment for gas. It may be a good idea to include in this book material on small buildings and dwellings as well as large buildings. A more appropriate title should be selected.

In the selection of material, only such data should be included as will be of interest to the persons to whom the book is to be distributed, and that which will adhere to the exploitation of gas, but at the same time, will not be unnecessarily detrimental to other lighting and fuel sources. Reference should be made to the fact that for the successful use of gas, efficient and durable appliances should be purchased. Only such appliances should be listed as have been proved and tested, and give entire satisfaction. Special mention should also be made of their proper installation.

In arranging the material, the information which the architects will use most frequently should follow the introductory page in which the purpose of the book will be given. The data should be given in paragraphs which are short and to the point. The topic of each paragraph should be set off in the margin of the sheet, as these marginal notes often result in attracting the attention of those who will scan but not read the entire production.

The book should be issued in loose-leaf form and contain pages not larger than 4 by 6 inches in size. This form of binding will permit the companies distributing the books to eliminate or substitute data which are not applicable to local conditions.

I believe the subjects outlined by the Committee fully meet requirements; and I am sure that in revising the report of the Committee on Piping Large Buildings for Gas which is given in the 1914 PROCEEDINGS of the American Gas Institute and which will form a large part of the data, the Committee will make the book sufficiently attractive to appeal to outside interests, and will insert nothing that will be objectionable from a gas company's standpoint.

MR. JANSEN HAINES (Des Moines): (Written discussion communicated.) I have gone carefully over the report as far as the work has been done, and beg to say that I fully agree with the scope of the report and the headings contained therein. I would suggest, however, that as it is obvious that the Committee will work largely on the conditions obtaining in large eastern cities, it will be well for the Chairman of this Committee to place one or two members from large western cities, whose practices and experiences would be valuable in aiding the Committee.

I would suggest some one from Chicago, St. Louis, or New Orleans where the practices undoubtedly differ and conditions are obviously not the same as in the east.

MR. ARTHUR HEWITT (Toronto, Ont.): (Written discussion communicated.) Apparently it was the original intention of the Committee to deal with large buildings only, but it has, I find, gotten together a most valuable and exhaustive mass of information, which apparently deals with every class of building. It was also originally intended that the Committee prepare a handbook for presentation to the architects, builders, plumbers, etc.

I would suggest that this information when being prepared for final publication, be arranged in such a manner as to make it most readily accessible by placing the contents in groups, dealing with the matter pertaining to various classes of buildings, completely and separately, which I believe should be as follows:

HOMES—Residences, Apartments and Dwellings.
HOTELS—Boarding Houses, Institutions.
STORES—Department, Grocery, Furniture, etc.
MANUFACTURING BUILDINGS—Loft Buildings.

WHOLESALE—Warehouses.
OFFICE BUILDINGS.
STUDIOS.

From our experience in Toronto in dealing with architects, I am convinced that unless the information regarding any subject is so prepared that it requires a minimum of effort on their part, it will receive practically no attention or consideration, so far as the architects are concerned.

MR. V. F. DEWEY (Detroit): (Written discussion communicated.) Perhaps it is well that the preliminary report of the Committee simply gives us a table of contents and a synopsis of what they propose to report. Otherwise, had it been written in full, it would have been almost impossible to have gone through the entire report in the time that any busy man could give to it.

Had it been intended to write a treatise on the gas business in general, I should have said that the table of contents was very satisfactory. I do not believe it would be practical to submit to our architects a voluminous report such as this would be when completed. I would suggest that the whole thing be boiled down and condensed into Section VIII—Gas Piping. If it is desired to issue a handbook, this can be issued in addition to the very useful pamphlet that could be gotten up.

MR. A. P. EWING (Detroit): (Written discussion communicated.) I don't believe you could send a book to the architect that covers the gas business from start to finish, and get very much benefit from it. If they want to send out a book that really gives arguments why a large building should be piped for gas, I say "Yes, it is mighty well worth while."

In the synopsis the report starts out with "The Uses for Gas," and then it is segregated into "The Uses in the Home"; "In the Industries"; "Gas for Illumination"; "Systems of Control"; "Hygienic Value"; "Gas as a Fuel"; "Gas as a Source of Power"; then under VIII Subdivision, "Gas Piping" is given.

In my estimation Division VIII is the only thing that should go into this report. The Appendix should be left off, and the synopsis of report should all be worked down in Section VIII. If you want to get a man to pipe a large building, you have got to give him good reasons why he should pipe that building. I don't think he wants to wade through "Gas for Power," Gas for Light," and "Gas for ——" and a lot of other things. He wants the concrete reason why he should pipe that building, and how he should pipe that building; what it will cost to pipe the building; why it will save money to pipe the building while it is being erected; and then for that particular building, he wants you to use your information to tell him what uses may be created.

The book should be explicit, and in a large part should cover just the heading of the Committee, that is, the "Supplying of Large Buildings with Gas," and I take this to mean large hotels, and large down-town buildings. It doesn't mean factory buildings. It doesn't make much difference when a factory building is piped, because the piping is all put in after the building is completed anyway.

I wouldn't include "stores in large buildings" except insofar as there was a store in the large building, but that wouldn't include the general piping throughout the building.

At the time this report was put together, Mr. Fogg wrote me, and I am inclined to believe that I gave him about this same information. It looks to me as if the Committee were trying to cover the whole gas industry in a volume about as big as the catechism.

Mr. J. A. Norcross (New Haven, Conn.): (Written discussion communicated.) The report of the Committee on Piping Large Buildings for Gas submitted to the Institute in 1914 marked an epoch in the history of gas lighting, *viz.*: the transition from stagnation, or worse, to renaissance.

For a number of years, the proportion of artificial lighting done by gas had been decreasing at a gradually accelerating rate.

The first places lost were the large buildings—theatres, churches, banks, hotels and office buildings of large size, and finally public buildings—Government, State and municipal. The loss of smaller buildings soon followed until in some cities most of the new and remodelled buildings even to the poorer houses were unpiped for gas or were piped only to the cellar or kitchen. But this was not the worst of the situation; the buildings already piped were dispensing with the use of gas for lighting and the pipes were sometimes cut off, sometimes removed, or left with the outlets concealed in such a manner as to have little chance of future use for lighting or any other of the "Thousand Uses for Gas." To sum up, the lighting business was being lost, and as a direct consequence, so was every opportunity for the sale of gas in the buildings where the lighting was no more. It is a striking fact that the question of cost never entered as a material factor in this loss of business. The several principal considerations for loss of gas lights were: first, lack of convenience; second, lack of adaptability; third, lack of gas fixtures and glassware to meet the present artistic standards; but fourth and by far the most potent cause was *neglect* on the part of gas managers themselves. It is easy to blame the inventors for their sterility, and the burner, fixture, and glassware designers and manufacturers for their failure to give to gas what they did to the successfully competing illuminant, but I think that few will deny that if the managers in the gas business had put as much energy and money to conserving and advancing the lighting business as they applied to gas cooking and industrial uses, the position of gas lighting would have been advanced five or possibly ten years earlier to what it is to-day and the history of our lighting business in this interval would read very differently. Existing gas lighting installations would have been looked after and brought up to date before their users became disgusted and gave them up—the existing business would have been conserved. New buildings would have been piped for gas and many would have used gas for lighting. In both old and new buildings the pipes would have been available for lighting and for many other uses for gas. In view of the recent great advances in gas burners, fixtures and glassware as to quality of light, adaptability, beauty, and convenience, and the success attending their competition, it is not too much to say that a large part of the gas lighting now lost would have been retained and to-day practically all buildings would be piped for gas throughout. With buildings piped, gas can be offered and sold for any purpose. With no pipes, no business can be done. But it is not yet too late. The lighting business still comprises from 50 to 60 per cent. of the business of most of our companies. To conserve it, we must do more than pipe large buildings for gas—but that is "another story." To get the business that is reasonably ours in new and remodelled buildings, it is absolutely necessary that these buildings be generously and thoroughly equipped with gas piping. The report of 1914 was evidence of the awakening on the part of the gas industry to the necessity of the present and the possibility of the future. In spite of the baneful and hindering influence of many combination gas and electric companies, the short-sighted policy of which was to down gas for lighting and relegate it to fuel uses, the gas industry has awakened. The book to be published as outlined by the 1915 report on "Supplying Large Buildings with Gas" will help those who still tremble with apprehension or hesitate in inaction. Buildings will be piped and the "Thousand Uses for Gas" made available to their occupants. Even combination companies will come to see that service can be rendered to the public and profit to the company by piping buildings for gas.

MR. J. D. SHATTUCK (Chester, Pa.): (Written discussion communicated.) I do not think that gas should be shut off in large buildings at any time after they are once supplied. There are so many pilot lights and other appliances that the meters should either be supplied with by-passes, or else there should be more than one unit, so that a unit could be taken out for repairs or test. The by-pass valve should be lock-wing pattern, so that it would be locked at all times except during the change of meter.

MR. C. A. LUTHER (Chicago): (Written discussion communicated.) While the report of the Committee apparently pertains to large commercial buildings, it lists under the Table of Contents—"Uses of Gas in the Home, its Advantages, etc." This, in my estimation, should be given as much consideration as the equipping of large commercial buildings. If the architect and owner can be convinced that gas is a necessity in the home, they are bound to give it the proper consideration in the large building. It is only too true that the average architect leaves off of his plans the equipping of the modern apartment building for gas lighting units.

I think that if the Committee included in its data book the absolute necessity of piping the home for gas by giving specific cases where gas has been of the utmost value not only for emergency purposes, but also from a safety standpoint, that it would carry considerable weight in the convincing of the proper parties that their buildings should be piped.

In the past year we have gone after the piping of the apartment and residence buildings in Chicago very strenuously with very good results; in fact we started a separate department as an experiment, to secure orders and pipe these types of buildings, and for the past year, we completed the complete installation of piping and fixtures for seventy six (76) cottages and seven hundred and seventy seven (777) apartments, making a total of eight hundred and fifty three (853) new meters set. This represented nineteen hundred and thirty one (1931) lighting outlets and nine hundred and eighteen (918) fuel outlets or a total of twenty eight hundred and forty nine (2849) additional outlets.

In the majority of cases, the stub was in to the curb or in to the building for fuel purposes only. The orders for the above were taken by only one man. This not only demonstrates that buildings can be piped, but also gives us some interesting data as to the cost of installation after the building has been completed.

MR. R. J. THOMPSON (San Francisco): (Written discussion communicated.) The necessity of a handbook for distribution among architects, builders, etc., on the subject of "Piping of Large Buildings for Gas" should be apparent to all, especially those situated on the Pacific Coast.

Not only is gas piping being omitted from large buildings, but from residences, bungalows, flats and apartments. Very little, if anything, is being done to introduce gas into these places except inadequately perhaps for use in the kitchen. It always has seemed to me that all buildings and dwellings should be as thoroughly piped for gas as they are wired for electricity, and as the life of a public utility selling gas is dependent upon its outlet, gas companies should be very much alive to the promotion by every means in their power, of the installation at the expense of the consumer at a time when it is least expensive to him, *i. e.*, during the construction of the building, of the vehicle by which their product may be introduced for use by the consumer, namely, gas piping in the homes. For it is the gas piping that carries the gas company product to a profitable conclusion; just as the littler arteries are necessary to carry nourishing blood to all parts of the body, so street mains are not doing their full work unless they are connected with full equipment of housepiping in every building along the lines.

I think it is fatal to a combination gas and electric company not to see a menace in their failure to as thoroughly extend their gas piping as they do their electric wiring, as the same can be done at a nominal expense to the builder if the piping is put in at the time the building is erected.

The various headings and different divisions given in the Table of Contents seem adequate thoroughly to acquaint anyone so desiring, with all the facts in connection therewith. It also seems to me that it might be well to bear in mind the idea of issuing new sections for the appendix, covering items of interest in this connection as they are brought forward from time to time, in the way of improvements, etc. I consider the appendix section to be one of the most valuable things to direct the mind of the architect, contractor or builder to the necessity of the use of gas. All our arguments for this will fail unless we can show them or suggest to them, devices to be installed and their proper, practical and artistic treatment. This, in addition to suggestions for an adequate run of pipe of proper size, as contained in Section VIII, are very important parts of this report.

THE PRESIDENT: The next is the report of the Committee on Utilization of Gas Fuel Appliances.

REPORT OF THE COMMITTEE ON UTILIZATION OF GAS FUEL APPLIANCES.

SECTION I—COOKING APPLIANCES.

The Gas Range Specification, while formally adopted by only a few gas companies, is very generally recognized by both gas companies and manufacturers, and practically all of the high grade ranges are constructed in accordance with its provisions.

The exigencies of the commercial exploitation of the "All Gas Kitchen" have shown a demand for the so-called "Campaign Range," which may be sold at a price considerably below that of the standard range. This demand has been met by a number of manufacturers, who have constructed ranges which do not in all respects comply with the Gas Range Specification, the difference being in the dimensions of the range top, or the ovens, and not in the quality of material or construction. Such deviation from the Specification is undesirable, and it is the opinion of your Committee that if there is an actual demand for a somewhat smaller range, the gas companies buying such ranges should insist that the manufacturer comply with the Specification in all respects except as regards dimensions of the burner top and ovens, and that, when referring to such ranges, the difference between them and standard ranges be clearly kept in mind.

The Specification was intended to cover only standard ranges, but it is couched in language so broad that it is applicable in most respects to others as well, and thanks to this, it has undoubtedly been of influence in maintaining a higher quality in the cheaper ranges than if it had not been formulated and adopted.

There has been a gradual development of the "fireless cooking," or heavily insulated, range, and there are indications of the attainment of perfection and the recognition of the value of this more efficient appliance.

For consumers living in the colder parts of the country, in houses not provided with means for heating the kitchen, combination gas and coal ranges have been found desirable because less space is occupied than by separate gas and coal appliances, and many good combination ranges are now on the market.

Because of peculiarities of construction, neither the fireless cooking, nor the combination range can be built entirely in accordance with the Gas Range Specification, but it is recommended that the general principles of range construction, and such parts as burners, cocks, manifolds, etc., described in the Specification, be closely followed.

For apartments or houses with small kitchens, "cookers" or ranges occupying minimum space are required. Such appliances, with only a baking burner in the oven, have been in successful use for many years. Recently these ranges have been constructed with an additional burner for broiling in the oven. It is thought that this construction should be encouraged, as it provides additional convenience for the consumer and demonstrates the advantage of broiling as a method of cooking. If both burners are in operation at one time, however, the combustion of the upper burner may be seriously affected, and means should be provided to prevent the use of both burners at one time.

It is, therefore, recommended that the following paragraph be added to Clause 16 of the Gas Range Specification:

> "If more than one burner is used in an oven, means shall be provided to prevent the simultaneous operation of the burners. (It is understood that the present common arrangement of a double pipe burner controlled by two cocks shall be considered to be one burner.)"

So far as is known to your Committee, no manufacturer is marking his ranges in accordance with the suggestion made last year. It is considered that such marking is desirable, and the suggestion made last year is repeated and recommended.

SECTION II—COCK GREASE.

The experiments to determine a satisfactory specification for cock grease are still under way, but have not yet reached the stage which warrants the writing of a specification.

SECTION III—WATER HEATING.

The past year has seen a rapid increase in the installation of automatic, or thermostatically controlled, circulating tank water heaters. This appliance gives satisfactory service when the tanks are properly lagged and the burners so constructed as to prevent a flash back, particularly on ignition. Because the gas is automatically turned on, it is very important that flue connections be used in all cases.

Use has shown that automatic instantaneous water heaters without thermostatic control give satisfactory service, except when uniform temperature of the water is required. At times the water may be hotter than desirable, but in many cases such slight inconvenience is more than offset by the lower first cost. It is advisable that there be some system of maintenance to assure the continued proper operation of water and gas valves.

SECTION IV—INDUSTRIAL APPLIANCES.

The use of gas for industrial purposes continues to increase and is being extended not only by more and better standard equipment, but also by the design, construction and installation of special appliances to suit individual needs, by the industrial divisions of the various gas companies. The field for this work is a wide one, and every encouragement should be given to those in charge of its development.

The outlook for the development of surface combustion is more favorable, and in one type of appliance at least—hotel boilers—it is proving thoroughly practical.

SECTION V—ROOM HEATING.

There has been no marked change in the appliances for this purpose. It is expected that a number of gas companies will experiment this fall and next spring with auxiliary gas-fired heaters attached to central house heating systems, whether hot air, hot water or steam, to see if it is not practicable to use gas as fuel during these seasons, when heat is required for but a small part of the day. Because it is difficult to operate a coal fire economically at such times, it is thought that gas should prove to be an ideal fuel.

The tests for efficiency of various types of gas room heaters, referred to in the report of this Committee last year, have been partially concluded, but the data cannot be collated in time for inclusion in the report this year. It is expected that these data will be ready for publication in a short time, and that they may be published in the Gas Institute *News* as an addendum to this report.

The Gas Fireplace Heater Design Competition, referred to in last year's report, has been held, and the award made. A separate report on this subject will be made by the Joint Committee of the Institute and the National Commercial Gas Association in charge of the competition.

SECTION VI—GAS TUBING AND ITS CONNECTIONS.

Composition-covered metallic tubing has proved its worth and its use is being extended.

Several companies have adopted one or another of the forms of connections described in last year's report, the union joint with fiber washer, either as then illustrated or modified to meet a particular design of connection, and the corrugated rubber end being favorites.

A standard design of slip-ends for use with hose cocks is in contemplation, but its full discussion with the manufacturers of such ends is not completed. Your committee believes that it is proper, however, to show as an exhibit the proposed design and to invite discussion thereon, with the purpose of obtaining information which will enable it to make a definite recommendation to the Institute next year.

SECTION VII—STANDARD BRASS FITTING THREADS.

At the present time there are no standards for the taps and dies used for threading brass tubing and fittings. While the differences between the tools made by the various manufacturers are small, they have been sufficient to cause much annoyance because of non-interchangeability.

A committee of the American Society of Mechanical Engineers has had the question of proper standards under consideration, and after conferring with the manufacturers of the tools and with those who use them, a report recommending a proper standard has been prepared and will probably soon be adopted by that Society. This report has been submitted to and approved by the directors of the American Gas Institute, the National Commercial Gas Association, the National Electric Light Association and other similar bodies. Such standards are highly desirable, particularly for gas, electric or combination fixture work.

The Gas Fixture Specification, therefore, should be changed as follows:

Paragraph A, Section I, "Sizes of Threads," now reads:

> "All threads on brass tubing should be straight threads of the size commonly known to the trade as 'gas fixture' or 'brass pipe' size, and should have, for all sizes of ¼ inch and over, 27 threads to the inch. If less than ¼ inch, the threads are to be 32 to the inch."

Change to read:

> "All threads on brass tubing should be straight threads to conform to the standard specification of the American Society of Mechanical Engineers for such threads."

SECTION VIII—FINISHES.

The recent rise in the price of spelter has caused an increase in the cost of galvanized metal, and substitutes are being sought therefor. Rust proofing the metal by oxidizing the surface, and the use of enamel, appear to be satisfactory, and an investigation of these processes is recommended. It is the belief of the Committee that single-coat enamel, while not as pleasing in appearance, is more desirable than multi-coat enamel, because it is less liable to chip.

Some confusion has arisen through the indescriminate use of the terms "enamel," "japan" and "lacquer," and it is suggested that in applying these terms the following definitions be used:

> "By lacquer, or japan, is understood a finish produced by the evaporation of a solution of organic material, generally resinous gums and the like, in a volatile solvent, generally a low boiling hydrocarbon. This evaporation may have been hastened by heating to a moderate temperature, say under 300° F.
>
> "By enamel is understood a vitreous finish produced by the fusion, or incipient fusion, at a high temperature, of a mixture of inorganic bodies such as silicates, fluorides, oxide of tin, etc."

W. J. SERRILL, *Chairman*,
G. S. BARROWS,
W. J. CLARK,
H. C. FRITZ,
D. E. KEPPELMANN,
J. A. NORCROSS,
W. H. PETTES,
G. D. ROPER.

MR. G. R. ALTHEN (Baltimore): Written discussion communicated.) Gas Ranges: Set screw for air shutters on burners should be easily accessible for adjustment. Many of the ranges which, in general, are designed as per standard gas range specifications, do not have the mixing cap screw in an accessible place.

Oven burners should not become red when heated to a reasonable degree, as there is a liability of warping.

The flue collar of a gas range should be so designed that a cooking utensil cannot be conveniently placed upon it. We do not believe that the scalloped edge entirely eliminates the possibility of explosion.

Water Heaters: Water heaters should not be approved unless they are provided with a pilot, or else a door for opening when lighting.

Instantaneous water heaters, if not provided with a thermostat, should be provided with a safety valve.

Gas Steam Radiators: All gas steam radiators should be provided with a safety valve set to blow at about 25 pounds pressure.

Gas Heaters: Gas heaters should be so designed that the temperature at the floor should not exceed 125° F. after an hour's burning.

Gas Irons: The gas iron which emits heat sufficient to raise the temperature at the handle to 150° F. should be provided with a shield to protect the hand.

Mr. G. R. **Chamberlain** (Grand Rapids, Mich.): (Written discussion communicated.) Referring to Section VI, "Gas Tubing and Connection," mention is made of a standard design of slip end for use with hose cocks. In view of the very strong stand which the Institute has taken the last few years as opposed to the rubber slip-end, it seems rather strange that the Committee is now proposing to standardize this method of connection, which has in the past proved itself to be so unsatisfactory. This would seem especially so in view of the fact that the metallic union has proved itself entirely satisfactory and infinitely superior to the rubber slip-end. In this regard we cannot do better than to cite our own experience. We have been following the work of the Committee for several years and on May 1, 1915, adopted the composition-covered metallic tubing for all of our tubing requirements—lamp, stove and flat-iron, and at the same time put into effect the system of union connection with fiber washer. The particular system that we adopted provides for suitable adaptor fittings by means of which the union can be connected to any existing gas outlet. At first we were rather concerned as to whether there would be confusion and difficulty in using this new union joint with existing hose and independent cocks, but we found that it is entirely practical to provide such cocks which are already on the customer's premises with threads, namely ⅛-inch standard burner thread, which permits using the adaptors above referred to. Or if the existing cocks are in poor condition, it is not difficult to induce the consumer to purchase a new one, or, on rare occasions, we feel that it is good business to take back the old cock and substitute a new one having threads. In this way we are gradually fixing up the existing outlet where tubing is connected in the premises of the various consumers, and in time will get them all changed over. We intend to work this matter in connection with a house maintenance campaign, which was inaugurated principally to take care of gas lighting burners, but which now takes in the full scope of gas appliances of every nature.

The union joint with fiber washer is safe, convenient, and practically indestructible. It is but little more expensive than the rubber slip-end, and it insures perfect satisfaction to the consumer. Since it has been amply demonstrated that the rubber slip-end can be supplanted by an absolutely safe type of connection, why should the Institute now reverse its former attitude and take what seems to us a distinct step backward?

Mr. W. M. Crane (New York): (Written discussion communicated.) In regard to a campaign range, would state that I have never been at all in favor of making a cheap range. For eight years the National Commercial Gas Association and the American Gas Institute have been trying to raise the standard of the quality of ranges, and made their specifications accordingly. Gradually gas companies were demanding of the manufacturers better ranges, and they had complied with the demand. Suddenly a manufacturer comes out with a "Special War Extra" going right back to and below where we had originally been. I note you say that the commercial exploitation seems to demand a cheaper range. I do not agree with that statement because I think the demand has come from some solicitors who want to make an easy sale. All gas ranges are so far below coal stoves in price that there can be no excuse for selling an inferior range.

In regard to a fireless cooker, would state that this does not appeal to us at all, because we have felt and still feel that the regular gas range is so convenient that the housewife is not willing to prepare her whole dinner two or three hours before the meal, that she may avail herself of the economies of the fireless cooker. Of course, there will be some demand for it.

In speaking of cookers or small ranges, the Committee states that recently these ranges have been constructed with an additional burner in the oven for broiling. That certainly is an error, because we and some other manufacturers have been making this type of cooker for at least five years, and we have also added a safety attachment which prevents lighting both burners at one time.

We have not marked our ranges according to the recommendations of the Committee because we have not felt that when some company required an attachment that was just as good as that recommended, we would want to say it was not a standard range, for it would be a standard as far as construction and durability is concerned, and yet we could not mark it "standard."

I think the use of gas both for industrial purposes and for house-heating will be greatly on the increase. As the different companies reduce the price of gas, it will make it possible to put gas for house-heating and industrial use on an economical basis rather than a luxury basis, and you can look for practical improvements in house heating appliances.

Mr. R. B. Brown (Milwaukee): (Written discussion communicated.) In going over the proof sheets of the report of the Committee on Utilization of Gas Fuel Appliances, there are several things that we, from our experience here, cannot agree with, and other things that it would seem as if the Committee should cover in more detailed manner; for instance, your comments on the Development of the Fireless Cooking

Type of Range on page 413. We, in our experience with several makes of this type of range, have not succeeded in getting work that would be passed as satisfactory baking by any of the experts that we have put it up to. The amount of gas used in baking in the average and small household is so small that the possibilities of saving are reduced to a figure which will not justify the insulated range if it is to be used as we find it commonly used.

Again, on page 413, you pass by the question of combination ranges in a way which would lead the uninformed or little informed reader to believe that there were several combination ranges on the market which would be satisfactory both to the gas company and to the consumer, and I think that the Committee certainly should have discussed this very important matter more in detail, and give their reasons for such a finding, which I believe is absolutely contrary to the conditions as we have found them. For instance, there has not been, as far as I know, a combination range made which presents the advantage of greater compactness (upon which you predicate the desirability of this type), which also gives the fullest possible efficiency and satisfaction in operation of the coal and gas ovens respectively, and I think this is to be expected.

The two methods of heating an oven are so dissimilar that an oven built to give satisfactory service and good efficiency heated with coal, cannot do equally well with gas. On the other hand, if the two ranges are built independently, as has been done, and simply combined in the same housing, the economy in space, which is desirable, is not obtained. We have found the most satisfactory solution in our practice, to be the addition of a coke heater, which, of course, can burn wood or coal equally well if the local conditions require, and the use of this coke heater for heating purposes and for such other work on the top as it is adapted to, leaving the baking to be done by the perfected gas oven, than which there is no better device known to the art.

In the section on Water Heaters, I would suggest that you modify your statement about satisfactory service from the use of intsantaneous heaters without thermostatic control, by warning against the use of this heater in circuit with coils in furnaces or boilers, and suggest with them the use of the usual hot water tank as a "tempering tank" on the inlet side of the heater, as, after all, the success or failure of this type of heater, depends upon reasonably uniform inlet water temperature and in the northern part of the country, this can be obtained only by taking care of these points, and we find that the average plumber and perhaps the average gas man, does not think of this until he has gotten into trouble.

Our industrial men question your statement as to the satisfaction obtained from the surface conbustion type of hotel broiler. We have been watching some of these installations, and they base their opinion on confidential reports obtained. In view of this, your statement sounds rather positive.

In Section V on Room Heating, we have been getting some remarkably satisfactory results with the English fire-places. As auxiliary heating devices in this cold climate, they are working out very well indeed, and we put out initial installations into the most difficult locations, and with the people hardest to please, as we believe, and have had no comebacks, but on the contrary the warmest approval.

We feel that we will be very much interested to see the report of your tests for efficiency of fireplace heaters and what it is based on in the way of requirements. The Fireplace Heater Design Competition seems to us, in view of our experiences in this character of work, to have been more or less of a fizzle, though the requirements of the people in other parts of the country and the conditions found, may vary enough to make the results of this competition look different to others.

We do not think that the gas tubing connection problem has yet been solved, though there are several designs which appear to approach a satisfactory solution at this time.

In your section on finishes, we would suggest some comments upon the results obtained during the past year from the use of single coated enamel finishes for oven linings and fittings.

In general, it would seem as though your report would be more valuable to the average reader if made more specific on many of the details, though I know, of course, that it is difficult to keep it within reasonable compass when you start to handle the items in that way.

Mr. R. C. Congdon (Atlanta): (Written discussion communicated.) I recognize the value of the gas range specifications, and think it desirable to have the ranges which meet these specifications marked in some suitable manner. In order that the specifications may prove of most value, it would seem that a very live committee to look after improvements would be necessary, but no doubt the Institute is taking care of this important feature.

The recommendation regarding change in clause No. 16 of gas range specifications certainly seems to be a desirable one. It seems unlikely that any cock grease will prevent the trouble we experience with this type of valve.

Regarding water heaters, it has been my observation that the principal dangers have been due to stopped flues, the flues in question being used to serve the heater as well as the kitchen range. Where there is but one flue for the dual purpose, there seems to be no certainty that the water heater will not prove in a measure dangerous.

Instantaneous water heaters with thermostatic control are being widely used in Atlanta. Likewise industrial appliances are being rapidly installed, and we have one man in our employ who is quite expert in designing and putting in use appliances to fill needs as they arise.

For room heating it would seem safest to have a tubing not longer than 2 feet, and that the gas supply should be taken from the wall near the baseboard. Heaters with screw connections and slip-end connections used with long tubing are liable to be in the way, and consequently, at times, torn from their connections. I was in hope that you would have something to say about the Rector Heating System. We have several installations of this type of heater in successful operation in Atlanta.

MR. O. H. FOGG (New York): (Written discussion communicated.) To me, the most interesting features of the Committee's report are those which emphasize the tendency toward improvement in the quality and efficiency of gas appliances. If the formulation of the standard specification has been in any degree responsible for this, it has indeed been worth while. There should be no let-down in the high standards of material and workmanship that have been arrived at; if anything, the effort should be to surpass them, and gas companies should be prepared to pay the legitimate difference in cost between appliances of indifferent design and construction and those of the better class. The exploitation of inferior appliances and accessories can only result harmfully to the development of the use of gas, and this fact is all the more apparent in the light of some of the recent activities of various regulating bodies. Fortunately, most gas companies realize the wisdom of handling only those appliances which can be counted upon to give satisfactory service and are known to be of good design and high class material and workmanship. There continues to be marketed, however, principally by small dealers and jobbers, appliances which do not meet these requirements, and which should have no place in the modern scheme of gas utilization. It should be the effort of the gas industry to eliminate, so far as lies within its power, this undesirable condition.

MR. ARTHUR HEWITT (Toronto, Ont): (Written discussion communicated.) The gas range manufacturers of the United States and Canada are to be congratulated upon the general high class of their products, and I am quite sure that in their various recommendations, the Committee has no idea of giving the impression that there has been any general failure on the part of the manufacturers to appreciate the importance of adhering as closely as possible to the standard American Gas Institute and National Commercial Gas Association specifications.

There is evidence of a demand for a gas range with an insulated oven, which will have less tendency to overheat the kitchen during warm weather. The overheated kitchen is not a common objection at present, but when attention is called to it by the electric stove vendor, as may soon be the case, we may be astonished to find how general the objection has become.

The combination gas and coal range seems to be gaining somewhat in popularity. Could it not be made to resemble a gas range rather than an augmented coal range?

I notice that the Committee refers to cookers as being necessary for small kitchens. In Toronto we do everything that is reasonably possible, to discourage the installation of cookers.

Water Heaters: I consider that every kind of gas water heater should be directly connected with a flue. In Toronto we absolutely refuse to connect any gas water heater which cannot be provided with flue connections.

Non-thermostatically controlled instantaneous heaters are not recommended in Toronto, because of the dangers attending their use, and the thermostat only adds $5.00 to the cost. This thermostat performs the dual purpose of making the heater safe, as well as keeping the water at the required temperature.

Could the Committee not, with advantage, put forth some effort towards the solution of the troubles experienced through copper coils giving way? There is a great similarity in the style of the coils used by the various tank heater manufacturers, most of which seem to be affected by the action of the gas upon them. In our experience, copper coils have given way repeatedly in six months, in what might be considered ordinary service. Investigation showed that these coils had all been affected in almost the same manner, and almost identically in the same spot.

It is to be regretted that more has not been said in the report, with reference to room heating. Do we realize what possibilities there are in this direction? Room heating by means of properly constructed and properly ventilated fireplace heaters, is practically an unexplored field. The development of this class of business has, in England, been most remarkable, and when we consider the thousands of homes in America in which asbestos grates and "Log" heaters have been installed, with generally most unsatisfactory results, it would appear to be high time that we develop a suitable fixture to meet the demand for room-heating.

I am glad to see that the Committee realizes that there is a demand for improvement in the connections for metal hose.

Industrial Appliances: Referring to Part 4 of the report, which deals with industrial appliances, I wish to say that, while the report refers to "Better Standard Equipment," each manufacturer, so far, has made his own standards; thus leaving the industrial gas man somewhat doubtful as to the correct classifications of the appliances.

While I do not believe that the time is yet ripe for making out any such detailed specifications, as has been done in the case of gas ranges, still I have little doubt that recommendations could be made which would give considerable assistance in judging the suitability of the appliances for certain classes of work. For instance, we all know that to maintain a temperature of 2000° F., a furnace requires more powerful burners and heavier linings, than to hold a temperature of 1200° F. Would it not be of value, if recommendations could be made for gas consumption, thickness of linings, and amount and kind of insulation advisable for high and medium temperatures? Also, could not some idea be given, as to the proper style of burner and air injector best suited for this work? Could not the much debated subject of water insulation for ovens, operating at temperatures of from 200 to 600°, be settled by some recommendations?

While examples given above may not be the exact subjects most necessary to be decided on, they serve to show what I mean, that is, that a start could be made somewhere, to put the business of gas fuel engineering on a somewhat higher plane than it is to-day. I think that nearly any industrial fuel man will admit that guesswork, based on experience, is principally relied upon to secure his business. While it must be admitted that this method has brought results, it only marks a transition period.

Data are being collected and arranged, with regard to a large part of the work, and I believe some standards or recommendations of the nature outlined above, will fit in with the work already being done, in a way that will be a mutual advantage to the gas consumer, the gas company, and the industrial gas engineer.

MR. DONALD McDONALD (Louisville, Ky.): (Written discussion communicated.) The report of the Committee on Utilization of Gas Fuel Appliances might with some propriety be called a report on the Standardization of Gas Fuel Appliances. Gas fuel appliances are becoming so general in their use, that the question is no longer how to get them introduced, but how to get them made in such a way as to afford the most satisfaction to the ultimate consumer.

Some of the manufacturers think that they make money when they turn out an article with special threads, so that the repair parts cannot be obtained from anyone except the original manufacturer. This policy may result in selling a few parts at extravagant prices, but it produces an immense amount of dissatisfaction, and causes many persons to condemn the device who might otherwise recommend it to their neighbors. I am sometimes asked the question "How can I get a good gas stove?" Formerly, I would name a few makes, and name them with fear and trembling. Now I have no hesitation in saying that all gas stoves are good—some are a little better than others. Many of us remember the time when a man would pay $150.00 for a bicycle because it carried a particular name plate, and it was worth the money. Bicycles of other makes had serious disadvantages. Now a bicycle can be bought for about $30.00, which is better in every way than the one for which we formerly paid $150.00 The same is true of appliances for using gas fuel. Nearly all the freaks have been eliminated, and most of those that remain on the market, generally speaking, will do the work for which they are planned.

I concur heartily in what the Committee has said as to the importance of gas water heating. This is one of the largest and most constant markets for gas. It affords the consumer a comfort for which he is willing to pay, and, generally speaking, the water heaters on the market are moderate in their consumption of gas, and satisfactory in the results accomplished.

Regarding Section V, which deals with room heating, it is no longer an experiment to place a hot air furnace using gas fuel alongside of a similar furnace using coal, the two air jackets being connected together with openings of ample size. The gas furnace will heat up almost instantly and will be used not only on the cool days in the spring and fall, but owing to its great convenience, its use will be continued except during that time when a fire must be maintained all day and all night.

Where only a single room is to be heated, the type of heater will depend upon the use to which the room is to be put. If the room is occupied constantly, the heater should have an efficient flue, and all of its products of combustion should pass up this flue. If it is desired to heat the room for short intervals, then a stove without a flue can be used.

The recommendation for standard threads for brass pipe is very important. It is hardly creditable to the people of the United States that such a recommendation should have to be made at this late day. Surely we have been a manufacturing nation long enough to appreciate the importance of standard threads, and to have gotten out of a condition, such that no one knows whether a piece of threaded brass pipe will actually screw into a brass fitting until he has tried it. This is one of those things that is a nuisance to everyone and a profit to no one.

Speaking generally, the report of the Committee seems to have been carefully considered, and to contain a great deal that will be of interest to the gas industry.

THE PRESIDENT: Are there any remarks on this report? There being none, I will call next for the report of the Committee on Next Place of Meeting. Mr. W. A. Wood, of Boston, is the Chairman of that Committee. In this connection, I will ask the Secretary if he will please state who sent invitations, although they may not influence the Committee.

THE SECRETARY: I may say I have a letter from Baltimore and one from Cincinnati.

REPORT OF THE COMMITTEE ON NEXT PLACE OF MEETING.

MR. W. A. WOOD (Boston): We have similar letters from Philadelphia, Boston and Chicago; these three are from the Chambers of Commerce. Of course, none of the cities mentioned can offer the advantages that Boston can; but after corresponding with the other two members of the Committee, and considering suggestions offered by several members of the Institute, the consensus of opinion seems to favor Chicago. We have agreed that it might be better to refer the whole matter with the invitations we have received, to the Board of Directors, and we so recommend.

THE PRESIDENT: In the absence of our President-elect, Captain McKay, owing to severe illness, and in view of Mr. Wood's report, if there is no objection, this matter will be referred to the incoming Board of Directors. Is there any objection? (No response.) If not, it will be so ordered.

MR. WALTON FORSTALL (Philadelphia): Before we adjourn the Institute meeting, it might be well to explain what has proved to be a little hard to understand, namely, our procedure for sectional nominations. The Constitution requires the Vice-President for each section to be chosen from three men designated by the members of that section the year previous. So if our five sections are to have any Vice-Presidents for the year beginning November, 1916, the members of the Institute now in this room will have to remain after the

Institute meeting adjourns, and then gather in sectional meetings, for the choice by each section of its three men.

THE PRESIDENT: After our adjournment, I will ask these different sections to have such meetings, and to nominate three names for consideration as Vice-President in each section, and they will report their findings to the Secretary. Your President would like, when we adjourn, if you will humor him to that extent, that we adjourn as of midnight of Friday, October 1st, in order that the various functions of entertainment may be carried on while I am President of the American Gas Institute.

If you see fit, these sections may report at the informal dinner at the Inside Inn on Thursday night, as the Institute will be still in session; and we will adjourn automatically at midnight October 1st. This is the shortest meeting of the American Gas Institute that has ever been held, and it is done in the interests of you good people. Is there any other business, gentlemen?

MR. G. I. VINCENT (Des Moines): I understand that the adoption of the report of the Technical Committee, which was read by the Secretary, puts it in full force and effect at once. There are certain recommendations of that Committee that must be carried out before Friday night. On page 53 the first recommendation is (and it is explained very clearly earlier in the report the reasons for the recommendation,) that the Technical Committee for the year be appointed by the President before the close of the annual meeting, and that the Chairman be preferably a member of the preceding committee. It is meant that the *incoming* President shall appoint the committee. I am bringing that information before this body.

MR. FORSTALL: I think it is perfectly proper that any report of this kind does not go into effect until the end of the meeting,—the annual meeting. Otherwise it is practically impossible to carry out this recommendation by the close of this meeting, as the meeting will end in two or three minutes.

MR. D. E. KEPPELMANN (San Francisco): I think that the provision requiring appointments by the incoming President is impossible, and I move that that portion of the Technical Committee's report be not approved.

(Motion seconded.)

THE PRESIDENT: It has been moved and seconded that that portion of the Technical Committee's report relating to the appointment of the entire membership of the Technical Committee by the President at this meeting be not approved.

MR. FORSTALL: I have been Chairman of the Technical Committee, and I think this Technical Committee attacked a real evil. The new sub-committees by which the work was done were always late in starting. This condition, however, has been already satisfactorily met by the Technical Committee, in using the power given it in the Constitution to continue the existing sub-committees.

If you are to have a successful Technical Committee, you must represent four or five different phases of the gas industry, and you want to represent each section if you can, and also the various ownerships in the gas industry. When you get such a committee, you get one that is useful. And as my friend, Mr. Vincent, did not let a sleeping dog lie, I think we should not wire to Captain McKay, but rescind that portion of the Technical Committee's report.

(Motion carried.)

THE PRESIDENT: What is your further pleasure, gentlemen?

MR. VINCENT: I move that we call a recess of the American Gas Institute until Friday midnight, October 1st, and that at that time we stand adjourned without further action.

(Motion seconded, stated and carried.)

Meeting adjourned to Friday, October 1st, midnight.

ACCOUNTING SECTION.

Tuesday, September 28.

Mr. T. R. Beal (Poughkeepsie, N. Y.), *Chairman,* presiding.

The meeting was called to order immediately after the adjournment of the Institute session, and was held for the purpose of selecting three names from which next year's Nominating Committee must choose one as the Vice-President representing the Accounting Section. The men chosen were:

F. H. Barnitz, New York, N. Y.
William McClellan, New York, N. Y.
H. W. Peck, Schenectady, N. Y.

CHEMICAL SECTION.

Tuesday, September 28.

Dr. A. H. Elliott (New York), *Chairman,* presiding.

The meeting was called to order immediately after the adjournment of the Institute session, and was held for the purpose of selecting three names from which next year's Nominating Committee must choose one as the Vice-President representing the Chemical Section. The men chosen were:

J. M. Morehead, Chicago, Ill.
C. C. Tutwiler, Philadelphia, Pa.
E. C. Uhlig, Brooklyn, N. Y.

DISTRIBUTION SECTION.

Tuesday, September 28.

Mr. G. I. Vincent (Des Moines), *Chairman,* presiding.

The meeting was called to order immediately after the adjournment of the Institute session, and was held for the purpose of selecting three names from which next year's Nominating Committee must choose one as the Vice-President representing the Distribution Section. The men chosen were:

J. W. Batten, Detroit, Mich.
C. C. Simpson, Jr., New York, N. Y.
G. I. Vincent, Des Moines, Ia.

ILLUMINATION SECTION.

Tuesday, September 28.

Mr. C. O. Bond (Philadelphia), *Chairman,* presiding.

The meeting was called to order immediately after the adjournment of the Institute session, and was held for the purpose of selecting three names from which next year's Nominating Committee must choose one as the Vice-President representing the Illumination Section. The men chosen were:

E. C. Jones, San Francisco, Cal.
Norman Macbeth, New York, N. Y.
J. A. Norcross, New Haven, Conn.

MANUFACTURING SECTION.

Tuesday, September 28.

Mr. E. H. Earnshaw (Newark, N. J.), *Chairman,* presiding.

The meeting was called to order immediately after the adjournment of the Institute session, and was held for the purpose of selecting three names from which next year's Nominating Committee must choose one as the Vice-President representing the Manufacturing Section. The men chosen were:

J. H. Eustace, Chicago, Ill.
G. B. Evans, St. Louis, Mo.
W. C. Morris, New York, N. Y.

In Memoriam

AUGUST 31, 1915

JOHN J. CREEDEN,

Died September 14, 1914

ADOLPH F. WEHNER,

Died January 22, 1915

ISAAC BATTIN,

Died February 12, 1915

CHARLES D. LAMSON,

Died February 12, 1915

EDWARD A. BEHRINGER,

Died March 26, 1915

DANIEL R. RUSSELL,

Died April 9, 1915

CHARLES H. DUNBAR,

Died April 21, 1915

WALTER W. RICHARDSON,

Died April 24, 1915

RILEY W. FARR, Jr.

Died June 10, 1915

JOHN J. CREEDEN.

Mr. Creeden, Chief Clerk, General Fuel Appliance Department, Consolidated Gas Company of New York, died September 14, 1914, in his 37th year.

Mr. Creeden had been continuously in the employ of the Consolidated Gas Company for 22 years. He was elected to Junior Membership in the American Gas Institute in 1911.

ADOLPH F. WEHNER.

Mr. Wehner, Secretary of the Isbell-Porter Company, Newark., N. J., died at his home in that city January 22, 1915, after a long illness, in his 56th year.

Mr. Wehner was born at New Haven, Conn., in 1859, and was graduated from the Sheffield Scientific School of Yale University in 1880. In 1882 he entered the employ of the Smith & Sayre Manufacturing Company, which company in 1890 became the Isbell-Porter Company. Upon the organization of the Isbell-Porter Company, Mr. Wehner was elected a Director, and upon the death of Geo. G. Porter, in 1893, Mr. C. W. Isbell was elected President and Mr. Wehner, Secretary of the company, which position he held until his death.

Mr. Wehner became a member of the American Gas Light Association in 1894, and was a Charter member of the American Gas Institute.

ISAAC BATTIN.

Mr. Battin died at West House, Swarthmore, Pa., February 12, 1915, in his 84th year, and was buried at the place of his birth, Millville, Pa.

Mr. Battin was one of the pioneers in the gas industry, being associated at first with his uncle, Joseph Battin, and employed in his early days at the plants in Elizabeth, N. J., Yonkers, N. Y., and Middletown, Conn. In 1861 he became Superintendent of the Albany, N. Y., Gas Light Company where he remained until 1887 when he entered the employ of The United Gas Improvement Company as Superintendent and Treasurer of the Omaha Gas Company, being the first of their employees to be retired about five years ago under their pension system.

He was the oldest surviving member of the American Gas Light Association, having been one of its first members (1873), was an Honorary Member of the Iowa District Gas Association, and a Charter member of the American Gas Institute.

His attendance for over half a century at the yearly gas meetings made him a wide acquaintance in the gas fraternity, a number of whom ascribe their success largely to his technical advice.

CHARLES DUDLEY LAMSON.

Mr. Lamson, President of the Worcester (Mass.) Gas Light Company since, 1888, died February 12, 1915, aged 73 years. Mr. Lamson was born in Cambridge, Mass., April 11, 1841, and completed his engineering course in the Lawrence Scientific School of Harvard University in 1866.

Mr. Lamson was one of the oldest members of the New England Association of Gas Engineers and its President in the year 1897. He became a member of the American Gas Light Association in 1881 and was a Charter member of the American Gas Institute. He was also, with one exception, the oldest member of the Society of Gas Lighting, having become a member in 1876. He was always active in association work, and his paper "A Pound of Coal," read before the American Gas Institute meeting in 1909, marked an epoch in the history of coal gas production. The effect of this paper was widespread; not only in the United States, but abroad were certain of its new principles adopted with profit. It is probably not too much to say this work by Mr. Lamson set new and higher working standards for the whole gas industry.

EDWARD ADOLF BEHRINGER.

Mr. Behringer was born in New York City, August 2, 1862, and was educated in the public schools of this city, graduating at the age of 13½ years. After leaving school he started with the firm of Greene, Tweed & Co., where he remained until he went into business for himself in the year 1887, the firm being Behringer, Parker & McCoy, mill supplies, gas bags, stoppers, etc., and later Edward A. Behringer.

He died March 26, 1915, at Miami, Fla., where he had gone in hope of recovering his health.

Mr. Behringer became an Associate member of the American Gas Institute in 1906.

DANIEL RENOUARD RUSSELL.

Mr. Russell, President of the D. R. Russell Engineering & Development Co., of St. Louis, Mo., died in New York City, April 9, 1915.

Mr. Russell was born in St. Louis, Mo., in 1862, and began his business career under his father, T. G. Russell, one of the founders of the Parker-Russell Mining & Manufacturing Co. In 1907 Mr. Russell became President and retained his position until 1914, when he organized the D. R. Russell Engineering & Development Co. Mr. Russell was a member of many gas associations; he became a member of the Western Gas Association in 1883, the American Gas Light Association in 1887, and became a Charter member of the American Gas Institute in 1906. He was also a member of the Canadian Gas Association, the Illuminating Engineering Society, the National Commercial Gas Association, the Pacific Coast Gas Association, and the Illinois, Michigan and Wisconsin State Associations.

CHARLES HENRY DUNBAR.

Mr. Dunbar died April 21, 1915, at the McLean Sanatorium, Waverly, Mass., where he had been taken for treatment. Mr. Dunbar was born at Pittsfield, Mass., June 11, 1869. He was educated in the local schools, and being desirous of a technical education, later entered the Worcester Polytechnic Institute, from which he was graduated in 1891 with the degree of Mechanical Engineer, and from Cornell University at Ithaca, N. Y., in 1894, receiving the degree of Electrical

Engineer. In 1895 he accepted a position with the American Gas Company as General Manager of the Elgin (Ill.) Gas Light Company. After 10 years in Elgin he accepted the position as General Manager of the Houston (Tex.) Gas Company, which prospered greatly under his supervision, and in 1912 the company was sold to the United Gas & Electric Corporation of New York City. Soon after, Mr. Dunbar suffered a nervous breakdown, and was for several months under the care of Chicago specialists.

Mr. Dunbar became a member of the American Gas Light Association in 1893, and was a Charter member of the American Gas Institute.

WALTER W. RICHARDSON.

Mr. Richardson, President of the Iroquois Natural Gas Co., at Buffalo, N. Y., died in that city April 24, 1915, after an illness of several years.

Mr. Richardson became an Active member of the American Gas Institute in 1906. He was formerly with the East Ohio Gas Co., of Cleveland, O., and had been connected with the old Buffalo Natural Gas Co. prior to his assuming the presidency of the Iroquois Company.

Mr. Richardson was in his 44th year at the time of his death.

RILEY W. FARR, JR.

Mr. Farr, in charge of the Electric Construction Department, Westchester Lighting Co., Ossining, N. Y., died June 10, 1915, in the hospital at that place, as a result of three operations.

Mr. Farr was born at Jenkintown, Pa., November 20, 1884, and was a graduate of the Law Department of the University of Tennessee. In 1906 he entered the employ of the Northern Westchester Lighting Co. in the Electric Department and later in charge of the Electric Construction Department. Mr. Farr was popular with his associates and a valuable member of the fraternity. He became a Junior member of the American Gas Institute in 1912.

CONSTITUTION AND BY-LAWS

OF THE

AMERICAN GAS INSTITUTE

CONSTITUTION

NAME.

SECTION 1. The name of this Association shall be the American Gas Institute.

OBJECTS.

SECTION 2. The objects of this Institute are to amalgamate into one body the American Gas Light Association, the Ohio Gas Light Association, and the Western Gas Association, and to facilitate co-operation between the various state and district associations that now exist, or may hereafter be formed within the territory covered, and to secure thereby the more rapid promotion and advancement of scientific and practical knowledge in all matters relating to the construction and management of gas works, and the manufacture, distribution and consumption of gas; the firmer establishment and maintenance of a spirit of fraternity between those interested in the gas business by affording opportunity for social intercourse and friendly interchange of information and ideas; the inducement and extension of more cordial and friendly relations between gas companies and consumers of gas based upon their mutual interests, and the education of employees of gas companies to enable them to better perform their duties. Also to take over such property and assets of the associations named as may be legally invested in the Institute.

MEMBERS.

SECTION 3. The membership of the Institute shall consist of Honorary, Active, Junior, Associate and Affiliated Members. Honorary, Junior and Associate Members shall not be entitled to vote except in section meetings as provided in Section 39 hereof, nor to hold office, but shall be entitled to all other privileges of membership. Affiliated Members shall be entitled to attend and take part in all meetings of the sections and the Institute, but shall have no voting privileges, and shall receive publications of the Institute only as provided in Section 56.

SECTION 4. Honorary Members shall be persons whose scientific or practical knowledge in matters relating to the gas industry, and whose efforts and interests in that behalf shall recommend them to the Institute.

SECTION 5. To be eligible to Active Membership, a person must be at least 26 years of age, and be an officer or other employee of a gas company; or a consulting expert in some branch of the gas industry. He must be competent to act efficiently as the manager of a department of a Gas Company's business and must have his chief interest in the gas business directly connected with the manufacture, sale, or utilization of gas, and not the manufacture or sale of apparatus or appliances used by Gas Companies.

SECTION 6. To be eligible as a Junior Member, a person must be over 20 years of age and be in the employ of a Gas Company, or of a consulting expert in some branch of the gas industry, and must be qualified either by experience or education to hold a responsible position under such employers.

SECTION 7. To be eligible as an Associate Member, a person must be engaged in a pursuit which constitutes a branch of the gas industry, or be otherwise qualified to assist in promoting the objects of the Institute.

SECTION 8. To be eligible as an Affiliated Member, a person must be a member of an association affiliated with the Institute in accordance with Section 55.

ELECTION OF NEW MEMBERS.

SECTION 9. Candidates for Honorary Membership, if endorsed by not less than ten members of the Institute, in writing to the Board of Directors, shall be voted upon by the Board, and if receiving the unanimous vote of the Directors voting, shall be voted upon by the voting membership of the Institute not less than one year thereafter by a special mail ballot.

SECTION 10. Every application for either Active, Junior or Associate Membership shall be made to the Secretary in writing upon a form approved by the Directors, upon which shall be set forth as the grounds of the application, a complete account of the qualifications and experiences of the applicant and his agreement to conform, if elected, to the Constitution, By-Laws and Rules of the Institute. Each applicant must be endorsed by at least two Active Members to whom he is personally known. The Secretary shall submit each application to the Membership Committee, who shall consider and act upon it and assign the applicant to the grade of membership to which, in their judgment, his qualifications entitle him. The name of each candidate thus approved by the Membership Committee, unless objection is made by the applicant, shall, after approval by the Directors, be submitted to the voting membership for election by means of a letter ballot. Every application for Affiliated Membership shall be accompanied by the dues and be endorsed by the Secretary of the affiliated association. Every applicant complying with these requirements shall be notified by the Secretary of his enrollment as an Affiliated Member.

SECTION 11. It shall be competent for any Junior, Associate or Affiliated Member to apply for transfer to another grade of membership. The application for such transfer shall be made in the same manner as in the case of a new applicant.

SECTION 12. Election to membership shall be by a sealed letter ballot as the By-Laws shall provide. Adverse votes to the number of 2 per cent. of the votes cast shall defeat the election of an applicant for any grade of membership. The Directors may, in their discretion, order a second ballot upon a defeated applicant, in which case adverse votes to the number of 4 per cent. of the votes cast shall be required to defeat the election.

SECTION 13. Any person elected to the Institute shall agree to comply with the requirements of the Constitution and, except in the case of Honorary Members shall pay to the Treasurer the initiation fee and one year's dues for his grade of membership before he can be entitled to the rights and privileges, or can receive a certificate of membership. If this requirement is not complied with within six months of the notification of the election, the applicant shall be deemed to have declined the election and the election shall be void.

INITIATION FEES AND DUES.

SECTION 14. The initiation fee for membership in each grade shall be as follows:

For Active Members.................	$10.00
For Associate Members..............	10.00
For Junior Members.................	5.00

The initiation fees shall not include the dues for the current year in which the applicant is elected.

SECTION 15. Any member on being transferred to any other grade of membership shall pay either the full initiation fee of the grade to which he is transferred or the difference between that initiation fee and the one he has already paid, except that Charter Junior Members shall not be required to pay such additional fee. No person shall retain Junior Membership for more than two years after becoming qualified for Active Membership.

SECTION 16. The annual dues, payable in advance, for membership in each grade shall be as follows:

For Active Members.................	$15.00
For Associate Members..............	15.00
For Junior Members.................	7.50
For Affiliated Members.............	2.00

SECTION 17. The Directors may in their discretion permit any Active or Associate Member to become a Life Member in the same grade by the payment in one sum of an amount sufficient to purchase from a reputable life insurance company an annuity on the life of a person of the age of the applicant equal to the annual dues in his grade of membership. Such life member shall not be liable thereafter for annual dues.

SECTION 18. The Directors shall have power by letter ballot to admit to Life Membership, without payment of a Life Membership fee, any person who for a long term of years has been an Active or an Associate Member, when, for special reasons, such an action would, in their judgment, promote the best interests of the Institute. Notice that such action is proposed shall have been given at a previous meeting of the Directors, and one dissenting vote shall defeat the proposed action.

SUSPENSIONS AND EXPULSIONS.

SECTION 19. Any member may retire from membership by giving written notice to that effect to the Secretary, and paying all dues to date, unless released from said payment by a vote of the Directors. A member whose dues for a year completely expired are not paid, shall not be entitled to vote, nor to participate in the deliberations of the Institute, nor to receive a copy of its publications. Any member whose dues shall remain unpaid for a term of three years may be dropped from the roll of membership by a vote of the Directors. A member dropped for non-payment of dues may, upon paying the amount he owes the Institute, be reinstated at the option of the Directors.

SECTION 20. The Directors may refuse to receive the dues of any member of any grade who shall have been adjudged by them to have violated the Constitution or By-Laws of the Institute, or who, in their opinion, shall have been guilty of conduct rendering him unfit to continue in its membership, and such person may be expelled from the Institute after notice and hearing by the Directors upon unanimous vote of the Directors present.

SECTION 21. The Directors may transfer any member from his then present to any lower grade of membership. They may also refuse to receive the dues of any member who is no longer eligible to any grade. No transfer of grade shall be made, or refusal to accept dues recorded, except upon notice from the Secretary, whose duty it shall be to give such notice, that said member is no longer eligible for membership in his then present grade, and that said member has for a period of ninety days after notification of such non-eligibility, failed to apply for transfer. The vote in each case shall be by ballot, and shall require two-thirds of the votes cast for its adoption.

MANAGEMENT.

SECTION 22. The affairs of the Institute shall be managed by the Directors, subject to the control of the general meeting.

SECTION 23. The Board of Directors shall consist of the President, the Vice-Presidents, the Secretary, the Treasurer, the Junior Past-President, and until changed as hereinafter provided for, ten Active Members of the Institute. Five members elected by the Institute shall constitute a quorum for the transaction of business. If arrangements are made for co-operation between the Institute and district and state gas associations, as hereinafter provided for, the number of members of the Board elected from the Active Members of the Institute shall be increased from time to time, as it becomes necessary, in order to keep the number of Directors elected by the Institute equal to not less than two-thirds of the total number of both Institute and Associate Directors.

SECTION 24. Should a vacancy occur in the Board of Directors or in any elective office, except that of President or Vice-Presidents, through death, resignation or other cause, the Directors may elect an Active Member to fill the vacancy until the next annual election.

SECTION 25. The Directors shall regulate their own proceedings, and may, by resolution, delegate specific powers to an Executive Committee, or to any one or more of their members. No act of the Executive Committee, or of a delegate, shall be binding until it has been approved by a resolution of the Directors.

SECTION 26. The Board of Directors shall present at the annual meeting of the Institute a report verified by the President, Secretary and Treasurer, or by a majority of the members, which shall show the state of the finances of the Institute at the date of the report; the receipts and expenditures for the fiscal year immediately preceding; the names and places of residence of the persons who have been admitted to membership in the Institute during that year, and give an account of the action taken by the Directors upon matters coming before them and recommendations as to the action to be taken by the Institute. This report shall be filed with the records of the Institute, and an abstract of it shall be entered in the minutes of the proceedings of the annual meeting.

SECTION 27. At each annual meeting there shall be elected from among the Active Members, a President, a Vice-President for each section into which the Institute is at the time divided, a Secretary, a Treasurer, and, until otherwise provided for, five Directors. All of the officers shall be elected for one year except the Directors, who shall be elected for two years.

OFFICERS.

SECTION 28. All elections shall be by ballot.

SECTION 29. The term of all elected officers shall begin on the adjournment of the annual meeting of the Institute at which they were elected. Officers shall continue in their respective offices until their successors have been elected and have accepted such election.

SECTION 30. The President and the retiring Active Members of the Board of Directors shall not be eligible for reelection the following year.

SECTION 31. At least four months previous to each annual meeting, it shall be the duty of the Directors to appoint a Nominating Committee of five members, none of whom shall be a Director. It shall be the duty of this Nominating Committee to report to the Secretary on, or before, July 15th, a list of the Active Members whom they recommend for election as Officers and Directors for the ensuing year. The Nominating Committee must select the Vice-President for each section from three Active Members, to be chosen by a majority vote of that section at the preceding annual meeting. The report of the Nominating Committee shall be published in full by the Secretary in the number of the Gas Institute NEWS for August, or separately, if necessary, at the discretion of the Secretary, and a copy of this number of the NEWS, or said separate circular, shall be mailed to each member entitled to vote not later than August 5th. Immediately following the report shall be printed in full Section 32 of the Constitution.

SECTION 32. Any twenty, or more, members entitled to vote may constitute themselves a Special Nominating Committee and may prepare a ticket in entire, or partial, opposition to the ticket prepared by the Nominating Committee, except that the nominee for Vice-President in each section must be selected from three Active Members, chosen by a majority vote of that section at the preceding annual meeting. Any such ticket shall be fully filled out with the names of the candidates for all of the offices and positions of Directors to be filled at the approaching election, by inserting the names of the nominees of the regular Nominating Committee where there are no opposing candidates nominated. Any such ticket must reach the Secretary on or before September 15th, and shall be published by him in full, together with the full list of members of such Special Nominating Committee, in the number of the Gas Institute NEWS for October, or separately, if necessary, at the discretion of the Secretary, and a copy of this number of the NEWS or such separate circular, shall be mailed to each member of the Institute entitled to vote not later than October

5th. Only such tickets as may be nominated in accordance with Sections 31 and 32 shall be considered at the annual meeting.

SECTION 33. The Directors shall appoint from their own number immediately after the meeting at which they are elected a finance committee of three members.

SECTION 34. The President shall take the chair at all meetings of the Institute wherever the members meet as one body and of the Board of Directors. He shall be an *ex-officio* member of every committee and sub-committee. He shall determine to which general committee any matter shall be referred.

SECTION 35. In the absence of the President, one of the Vice-Presidents shall take the chair; if more than one Vice-President be present in the absence of the President, the Vice-President to preside shall be determined by lot, and in the absence of the President and Vice-President, a Chairman shall be appointed by the Directors from among their own number. Each Vice-President shall be the presiding officer of the section for which he was designated on nomination. He shall be *ex-officio* member of each committee relating solely to the work of his section.

SECTION 36. The Secretary shall be present at all meetings of the Institute and of the Board of Directors, and shall take and keep the minutes thereof. He shall conduct the correspondence of the Institute, read minutes and notices of all the meetings and also such papers and communications as are considered in the absence of their authors, and perform whatever other duties may be required of him by the Constitution and By-Laws. There also shall be a Secretary for each section, to be appointed by, and having the same term of office as, the Chairman of the section. His duties shall be in general to assist in conducting the meetings of his section.

SECTION 37. The Treasurer shall collect and have charge of all funds of the Institute. He shall pay all bills approved by the President and a member of the Finance Committee, and shall keep book accounts of all receipts and expenditures. He shall make an annual report.

SECTION 38. The duties of the Finance Committee shall be to audit the books, accounts and statements of the Treasurer; to invest the funds of the Institute, and to care generally for the finances of the Institute, subject to the control of the Directors.

SECTION 39. The duties of the Directors shall be to have the general management of the affairs of the Institute, and to prepare for its meetings. No paper or report that has not had the approval of the Directors shall be read at any meeting of the Institute or any section thereof.

The Directors shall have the power to appoint, from time to time, a Committee on Arrangements from among the members, to assist the Directors in arranging for the meetings of the Institute. The Directors shall have power to provide for the voluntary division of the membership into two or more sections for the choice of sectional Vice-Presidents and for the hearing and discussion of papers and reports. The functions and powers of each section shall be limited to the nomination of a Vice-President, the provision and consideration of papers and reports, the reference to committees, and to recommendations to the Institute or to the Board of Directors. Any member of the Institute may attend the meeting of any section at any time. Any Honorary, Active, Associate or Junior member in good standing may vote on the election of section officers or on other matters connected with section organization in one section only, and to so vote must register as a voting member of such section. He may change this registration on one year's notice to the Secretary of the Institute, provided that this notice be waived in the case of each member making application to form a new section.

Upon the written application to the Directors of any thirty members of the Institute asking for the creation of a new section, the Directors shall proceed to form the section applied for.

Any resolution, report or recommendation that has not been considered and approved by the Directors, and that in the opinion of the Chair would have the effect of changing the policy of the Institute, or committing it to any new policy or opinion to which it had not theretofore been committed, shall be referred, before adoption, to the Board of Directors, whose duty it shall be to report to the next regular meeting of the Institute upon such committal, if any, and its proper phrasing.

SECTION 40. There shall be two general committees, each reporting to the Board of Directors and responsible to the Board for such part of the work of the Institute as is delegated to it in accordance with Sections 34, 41 and 42. Each committee shall be composed of at least six members, appointed each year by the President after the annual meeting, to serve one year.

SECTION 41. One general committee shall be called the Public Relations Committee, and to it shall be referred all investigations, reports, recommendations, resolutions and matters of any kind affecting the relations between the Institute, or its members, and the public, or any governing bodies, except as herein provided.

SECTION 42. One general committee shall be called the Technical Committee, and to it shall be referred all investigations, reports, recommendations, resolutions and matters of any kind having to do with the construction, operation and extension of gas works, and the conduct of the affairs of gas companies, not specifically delegated to the Public Relations Committee by Section 41, and except as herein otherwise provided. Each section shall have a representative on this Committee.

SECTION 43. Each general committee shall have the power to appoint subcommittees. Any subcommittee may be appointed from the general membership of the Institute, and shall exist at the pleasure of the general committee by which it was appointed, and to which its report shall be made.

MEETINGS AND PROCEEDINGS.

SECTION 44. The annual meeting of the Institute shall be held on the third Wednesday of October of each year, at such place as shall be designated by the Institute at the previous meeting. In case of emergency, the Directors shall have the power to change the time or place of meeting, or both, as so designated, by a three-fourths vote of all its members, at the call of the President, and such vote may be taken by mail.

SECTION 45. The Secretary shall send notices to all members of the Institute at least fourteen days before each general meeting, mentioning the papers to be read and any special business to be brought before the meeting. During a recess in any meeting of the Institute, taken in order that section meetings may occur, no meeting of the Institute other than as provided at the time the recess is ordered shall be held until one hour after a call for such meeting has been read in each section meeting in session at the time, and has been posted on the official bulletin board. The President shall have the authority to issue such call, and it shall be obligatory to him to issue such call on the written request of fifty members.

SECTION 46. Special meetings of the Institute may be called at the option of the Directors, and the Secretary shall call a special meeting on the written request of one hundred members. The notices for special meetings shall be sent to all members at least three weeks before the date for which the meeting is called, and shall state the business to be transacted, and no other shall be entertained.

SECTION 47. Thirteen members shall constitute a quorum.

SECTION 48. All questions, except as otherwise provided in Sections 9, 20, 28, 49 and 57, shall be decided by any convenient system of open voting, the presiding officer to have a second or casting vote when necessary.

SECTION 49. Questions of a personal nature shall be decided by ballot and all parliamentary procedure not specifically covered by this Constitution shall be governed in accordance with Roberts' Rules of Order.

SECTION 50. Any member, with the concurrence of the presiding officer, may admit a friend to each meeting of a section or of the Institute, but such person shall not take part in any of the discussions unless permission to do so be given by the meeting.

SECTION 51. All papers read at the meetings of the Institute must relate to matters either directly or indirectly connected with the objects of the Institute.

SECTION 52. All papers, drawings or models submitted to the meetings of the Institute shall be and remain the property of the authors.

SECTION 53. The President, the Junior Past-President, the Junior Past-Chairmen of the two general committees, and the Secretary shall constitute a Publication Committee, and nothing shall be included in the published reports of the Institute's proceedings, or in any other publication issued by its authority, that has not been approved by at least three-fifths of the full membership of the Publication Committee.

SECTION 54. The Directors shall meet the day before each general meeting of the Institute, and also on such days between June 1st and September 15th, both inclusive, as may be designated by the President, by notice given at least one week in advance of meeting. Special meetings may be called when the President shall deem it necessary, and the President shall be required to call a special meeting at any time on the written request of five members of the Board. Of such meetings reasonable notice shall be given by special call, in print or writing, specifying the business to be attended to.

GEOGRAPHIC AND DISTRICT SECTIONS.

SECTION 55. The Board of Directors may in its discretion make with any gas, electric or gas and electric association, an affiliation agreement, upon such terms as may be mutually agreed upon, providing the membership or objects or interest of such association are not in conflict with those of the Institute. An affiliation agreement shall provide for the termination of such agreement on twelve months' notice by either party.

An affiliation agreement may provide for representation of the affiliated association on the Board of Directors of the Institute, but in such cases said association shall at no time have more than 20 per cent. of its voting membership persons not directly identified with gas or electric interests within the state or district designated by the name of the association; and said association shall agree to present the result of work of interest in the form of a report to the Board of Directors of the Institute; such affiliated Associate Directors shall be additional to the Institute Directors provided for in Section 23, and shall at no time exceed one-third of the total.

On all matters pertaining to public relation, the Institute and the affiliated association shall agree to co-operate, and the latter shall consult with and be advised by the Public Relations Committee before taking official action on these matters. The services of the Public Relations Committee shall be available to the affiliated association in return for payment of actual expenses incurred.

Upon request of the affiliated association the Technical Committee will co-operate in all matters within its province. Abstracts of papers presented to the affiliated association will, after approval by the Technical Committee, be published in the NEWS, as will complete papers undertaken by agreement with the Technical Committee.

PUBLICATIONS.

SECTION 56. With the exception of Affiliated Members, each member of the Institute in good standing shall be entitled to and shall be furnished by the Secretary with a copy of the PROCEEDINGS of the Institute for the current year, in which shall be listed the names and addresses of the members. In any such list, each member shall be listed by the title, or titles, only, from which he derives his eligibility to his class of membership. Affiliated Members shall, in return for their dues, receive the Gas Institute NEWS, and at members' prices, any other publications of the Institute.

SECTION 57. Any proposition for adding to or altering any of the provisions of the foregoing Constitution shall be laid before the Directors, who, if they see fit, may bring it before the next general meeting of the Institute, and who shall be bound to do so on the requisition in writing of any ten members of the Institute. All such propositions shall be decided by ballot and shall require two-thirds of the vote cast for their adoption.

BY-LAWS

(Section numbers in parentheses refer to the Constitution.)

1. (SECTION 10.) Each member proposing a candidate for admission is required to make a confidential communication to the Secretary for forwarding to the Membership Committee, setting forth in detail such information, personally known to referee, as shall enable the Directors to decide upon the eligibility of the candidate for admission to the Institute, except that in the event of the requisite number of members in good standing having personally signed the application of a candidate, this may be deemed sufficient endorsement, and the requirement of the confidential communication referred to above shall not be obligatory, but shall be optional at the discretion of the Membership Committee. The Secretary shall be the judge of the competency and the signature of referees.

2. (SECTION 10.) In the absence of replies from the referees to inquiries for information, or if replies are not sufficiently explicit, the Secretary shall cause the applicant to be notified, and the application shall be held in abeyance.

3. (SECTION 10.) At a meeting subsequent to their election, the Directors shall appoint from their number, four, to be a committee on election of new members. This committee shall pass on all applications for membership, and report to the Directors. Any correspondence in regard to an applicant shall be destroyed when his name has been placed upon a voting ballot, or upon withdrawal of the application.

4. (SECTION 12.) The Secretary shall, twice a year, on or about the first day of March and of September, mail to each member entitled to vote, a ballot stating the names and respective grades of the candidates for membership in the Institute which have been approved by the Directors, and the time of the close of voting. The voter shall prepare his ballot by crossing out the names of candidates rejected by him, and shall enclose said ballot in a sealed blank ballot envelope, which he shall then enclose in a second sealed outer envelope

on which he shall, for identification, write his name in ink. The ballot thus prepared and enclosed shall be mailed or delivered unopened to the Secretary, which shall be counted as an affirmative vote on all the names not crossed out. The Secretary shall be the judge of the competency and the signature of all voters. On the close of the voting, the Secretary shall first open and destroy the outer envelopes, and shall then canvass the ballots, and certify the result to the Membership Committee.

The Secretary shall not receive any ballot after the stated time of the close of voting. A ballot without the endorsement of the voter, written in ink on the outer envelope, shall be considered as defective, and rejected by the Secretary.

The names of those persons elected to membership, with their respective grades, shall be embodied in a written report, signed by the Secretary, and presented to the next meeting of the Institute. The President shall then declare them duly elected to membership in the Institute. The Secretary may, in advance of any meeting, advise each candidate of the result of the canvass of the votes in his case. The names of applicants who are not elected shall neither be announced nor recorded in the PROCEEDINGS.

The endorser of an applicant who has not been elected, may, with his consent, present to the Directors a written request for a re-submission of his name to ballot. The Directors may, in their discretion, by a three-fourths vote of the members present, order the name of the applicant placed on the next ballot for members.

5. (SECTION 13.) Section 13 of the Constitution shall be printed upon the notification of election to all members except Honorary Members.

6. (SECTIONS 14 and 16.) The initiation fee and annual dues of the first year shall be due and payable on notice of election to membership. Bills for the fee and dues should accompany the notification of election. Thereafter the annual

dues shall be due and payable on the first day of September of each year.

7. (SECTIONS 14 and 16.) Upon payment of the initiation fee and annual dues, a newly elected member shall receive copies of any publications of the Institute, which may have been distributed without charge to the members during that year, even though the date of issue of these publications is prior to that of the election of such member.

8. Each member shall be entitled to a badge upon payment of an amount to be fixed from time to time by the Directors. Upon his ceasing to be a member, he shall return his badge, and receive therefor the sum of $2.00.

9. Each member shall be entitled to a certificate of membership in accordance with his grade, signed by the President and Secretary. Every such certificate shall remain the property of the Institute, and shall be returned to the Secretary on demand of the Directors.

10. (SECTION 19.) The Treasurer shall present to the Directors the name of any member in arrears for more than one year.

11. (SECTION 20.) At least one month's notice shall be given to the Directors and to the member who is to be heard.

12. (SECTION 26.) The Secretary shall furnish the Directors with the information needed for their annual report, excepting only as to finances, or to matters which have been entrusted to special committees. The financial report shall be made by the Treasurer to the Finance Committee.

13. (SECTION 26.) The fiscal year of the Institute shall begin September 1st.

14. (SECTION 28.) The President shall, at the first session of the Annual Meeting, appoint three Tellers of Election, who shall canvass the vote cast for officers, and report the result to the meeting.

15. (SECTION 31.) The Nominating Committee shall report at the first session, and a ballot be taken on their report

at once unless twenty or more members object. In such case, the ballot for officers shall take place at the first session of the second day, in the manner prescribed in By-Law No. 15.

16. (SECTION 31.) If the report of the Nominating Committee is not unanimously adopted, the Tellers of Election shall distribute ballots among the members at once, unless the election is postponed, as covered by By-Law No. 14. In either case, poll may be opened outside the meeting room in some adjacent and convenient place. If there is no objection, one ballot may be cast for those nominated by the committee.

17. (SECTION 33.) When the appointment of a chairman is not included in the appointment of a committee, the latter shall elect their own chairman.

18. (SECTION 36.) The Secretary shall be in charge of the membership lists. He shall also be in charge of all other property of the Institute not distinctly pertaining to the Treasurer's work.

19. (SECTION 37.) The annual report of the Treasurer shall be embodied in the financial report of the Directors.

20. (SECTION 37.) Neither the Treasurer nor any other officer of the Institute shall pay out money except upon bills approved by the President and a member of the Finance Committee.

21. (SECTION 37.) The Treasurer shall furnish a bond for the faithful performance of his duties to such amount as the Finance Committee may require, such bond to be procured from an incorporated gurantee company at the expense of the Institute.

22. (SECTION 39.) The President, subject to subsequent approval by the Directors, may, in his discretion, appoint a member or members of the Institute to represent it at meetings of associations of kindred aim or at public functions. Such delegates should be designated as "Honorary Vice-Presidents," and their duties shall terminate with the occasion for which they are appointed.

23. (SECTION 39.) Not later than six months prior to each annual meeting of the Institute, the Directors shall appoint an Arrangement Committee to have charge of all the details connected with the annual meeting, except only as to papers.

24. (SECTION 39.) The voting lists for section matters shall be drawn up from the list of members as published in the last volume of the PROCEEDINGS, in which the section registration of each member shall be shown.

25. (SECTION 44.) The President shall appoint a committee of three to recommend the place to be designated by the Institute for the next annual meeting.

26. (SECTION 57.) Amendments of, or additions to, the By-Laws may be adopted by the Directors by a unanimous vote at any meeting. When objection is made, two weeks' notice and copy of the proposed changes shall be sent to each Director. At any meeting subsequent to such notice, a two-thirds vote will be sufficient for adoption.

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MEMBERS

OF THE

AMERICAN GAS INSTITUTE

HONORARY MEMBERS.

BONE, PROF. WILLIAM A., September, 1912.
Professor in the Imperial College of Science and Technology, South Kensington, London, S. W., England.

CHANDLER, CHARLES F., PH. D., M. D., LL. D., D. Sc., September, 1910.
51 East 54th Street, New York, N. Y.

KING, WILLIAM, September, 1910.
5 Beach Lawn, Waterloo, Liverpool, England.

WOODALL, SIR CORBET, September, 1910.
Palace Chambers, Bridge Street, Westminster, S. W., London, England.

LIFE MEMBERS.

EGNER, FREDERIC, October, 1906.
Consulting Engineer, Retired, 516 Quincy Street, N. W., Washington, District of Columbia.

SLATER, ALPHEUS B., October, 1906.
Consulting Engineer, Slocums, Rhode Island.

ACTIVE MEMBERS.

ABELL, H. C., October, 1906.
Chief Engineer, American Light & Traction Company, 40 Wall Street, New York, New York.

ADAMS, B. C., October, 1906.
Vice-President and General Manager, Montgomery Light & Water Power Co., Montgomery, Alabama.

ADAMS, H. C., October, 1906.
Vice-President, Westmoreland Coal Company, 224 South Third Street, Philadelphia, Pennsylvania.

ADAMS, OLIVER WINCHESTER, September, 1911.
Superintendent, Holyoke Gas Works, City Hall, Post Office Box 218, Holyoke, Massachusetts.

ADAMS, ROBERT MORFORD, March, 1913.
Secretary and Treasurer, Los Angeles Gas & Electric Corporation, 645 South Hill Street, Los Angeles, California.

P = Present at San Francisco Meeting.
For Sectional Registration see Geographical List, page 578.

ADDICKS, WALTER R., October, 1906.
Vice-President, Consolidated Gas Company of New York, 130 East 15th Street, New York, New York.

AFRICA, WALTER G., October, 1906.
Treasurer and Manager, Peoples Gas Light Company, 39 Hanover Street, Manchester, New Hampshire.

ALDEN, JOHN DOUGLAS, March, 1910.
Assistant, Bronx Gas & Electric Company, 1520 Overing Street, Westchester, New York.

ALLEN, ARTHUR BENJAMIN, March, 1914.
Assistant Superintendent, New York Mutual Gas Light Company, 825 East 11th Street, New York, New York.

ALLEN, WILLIAM H., JR., September, 1909.
Superintendent, By-Products Coke Corporation, Semet-Solvay Coke Ovens, South Chicago, Illinois.

ALLISON, WALTER A., October, 1906.
Engineer, 403 Wister Street, Philadelphia, Pennsylvania.

ALLYN, GEORGE E., October, 1906.
Superintendent of Distribution, Providence Gas Company, Turks Head Building, Providence, Rhode Island.

ALMBERG, H. E., September, 1913.
Attorney for Consolidated Gas Company of New York, 130 East 15th Street, New York, New York.

ALRICH, HERBERT W., March, 1909.
Assistant Engineer of Construction, Consolidated Gas Company of New York, 130 East 15th Street, New York, New York.

ALTHEN, GEORGE R., September, 1912.
General Superintendent of Distribution, Gas Division, Consolidated Gas, Electric Light & Power Company, 1068 North Front Street, Baltimore, Maryland.

ALTHOUSE, A. J., September, 1912.
Superintendent, Hamburg Gas & Electric Company, Hamburg, Pennsylvania.

AMBLER, THOMAS MARSHALL, September, 1914.
Manager, Commercial Department, Brooklyn Union Gas Company, 176 Remsen Street, Brooklyn, New York.

AMES, KNOWLTON L., October, 1906.
Jacksonville Gas Company, 108 South La Salle Street, Chicago, Illinois.

Andersen, Howard Bruce, September, 1911.
Superintendent City District, The United Gas Improvement Company, 1931 South 9th Street, Philadelphia, Pennsylvania.

Andrews, Charles Harold, March, 1912.
Assistant General Manager, North Carolina Public Service Company, Greensboro, North Carolina.

Andrews, C. W., October, 1906.
Treasurer, Zenith Furnace Company, 404 West First Street, Duluth, Minnesota.

Andrews, J. Charles, October, 1906.
Turner Construction Company, 11 Broadway, New York, New York.

Angell, Frederic J., September, 1908.
Mechanical Engineer, 38 Victoria Street, Westminster, London, S. W., England.

Arkwright, P. S., October, 1906.
Vice-President, Atlanta Gas Light Company, Electric & Gas Building, Atlanta, Georgia.

Armstrong, H. V., March, 1912.
Assistant Superintendent, Gas Department, Northern Indiana Gas & Electric Company, South Bend, Indiana.

Armstrong, J. H. N., March, 1911.
Statistician, Consolidated Gas Company, 130 East 15th Street, New York, New York.

Ashworth, James, September, 1910.
Superintendent of Distribution, Public Service Gas Company, St. Paul and St. James Avenues, Jersey City, New Jersey.

Ayres, Chester T., September, 1908.
Works Manager, Union Carbide & Electro-Metallurgical Company, 30 East 42d Street, New York, New York.

Baehr, William Alfred, October, 1906.
Consulting Engineer, Peoples Gas Building, Chicago, Illinois.

Bain, Ferdinand R., September, 1914. (P)
President, Southern Counties Gas Company, 616 Title Insurance Building, Los Angeles, California.

Bains, George B., 3d, October, 1906.
Engineer, Consumers Gas Company, 441 Penn Street, Reading, Pennsylvania.

Ball, James, October, 1906.
Assistant Secretary and Treasurer, United Gas Improvement Company, Broad and Arch Streets, Philadelphia, Pennsylvania.

Ball, Samuel, September, 1911.
Manager, Bay City Gas Company, 520 Centre Avenue, Bay City, Michigan.

Parker, Perry, September, 1911.
Fuel Engineer, Arthur D. Little, Inc., 141 Milk Street, Boston, Massachusetts.

Barker, William S., September, 1911.
Assistant Treasurer, Public Service Gas Company, 763 Broad Street, Newark, New Jersey.

Barlow, Thaddeus Scott, September, 1910.
Superintendent, Consolidated Gas Company, 302 East 99th Street, New York, New York.

Barnes, Albert Mallard, September, 1907.
President and General Manager, Cambridge Gas Light Company, 719 Massachusetts Avenue, Cambridge, Massachusetts.

Barnitz, Frank R., September, 1908. (P)
Assistant Secretary, Consolidated Gas Company of New York, 130 East 15th Street, New York, New York.

Barnum, Dana Dwight, March, 1911.
President and General Manager, Worcester Gas Light Company, 240 Main Street, Worcester, Massachusetts.

Barret, A. H., October, 1906.
Retired, Louisville Gas Company, 127 North 3rd Street, Louisville, Kentucky.

Barrett, William E., October, 1906.
Gas Engineer, Room 1902, 43 Exchange Place, New York, New York.

Barrett, William Felton, September, 1908.
Consulting Engineer, 42d Street Building, 30 East 42d Street, New York, New York.

Barrows, George S., October, 1906.
In charge of the Gas Heating Department, General Fire Extinguisher Company, 275 West Exchange Street, Providence, Rhode Island.

Barthold, W. H., October, 1906.
Gas Engineer, Hodenpyl, Hardy & Company, 14 Wall Street, New York, New York.

Batten, J. W., March, 1909.
Engineer, Detroit City Gas Company, Gas Office Building, Detroit, Michigan.

Battin, Henry S., October, 1906.
Assistant to General Superintendent, United Gas Improvement Company, Broad and Arch Streets, Philadelphia, Pennsylvania.

Baurhyte, William, October, 1906.
First Vice-President, Los Angeles Gas & Electric Corporation, 645 South Hill Street, Los Angeles, California.

Baxter, Isaac C., October, 1906. (P)
Upland, San Bernardino County, California.

Bayly, C. **Clay**, October, 1906.
Assistant to Engineer, Washington Gas Light Company, 413 Tenth Street, N. W., Washington, District of Columbia.

Beadenkopf, George, October, 1906.
Engineer, Consolidated Gas, Electric Light & Power Company, Lexington and Liberty Streets, Baltimore, Maryland.

Beadle, Albert B., October, 1906.
Consulting Gas Engineer, 1328 Chestnut Street, Philadelphia, Pennsylvania.

Beal, A. R., October, 1906. (P)
Contract Agent, Central Hudson Gas & Electric Company, 129 Broadway, Newburgh, New York.

Beal, T. R., October, 1906. (P)
President, Central Hudson Gas & Electric Company, 50 Market Street, Poughkeepsie, New York.

Beardsley, Alling P., September, 1915.
Chemist, Cott-a-lapp Company, Somerville, New Jersey.

Beaumont, Walter W., September, 1907.
Superintendent of Transportation, The United Gas Improvement Company, 4650 Market Street, Philadelphia, Pennsylvania.

Becher, Eugen, March, 1913.
Chief Engineer, Blaugas Company of America, 25 Madison Avenue, New York, New York.

Beck, George W., October, 1906.
Superintendent, Northumberland County Gas & Electric Company, Sunbury, Pennsylvania.

Bell, Ernest William, October, 1906.
Consulting Engineer, 14 Wall Street, New York, New York.

Benedict, Clarence M., September, 1908.
Assistant Secretary and Treasurer, Charleston Consolidated Railway & Lighting Company, Charleston, South Carolina.

Bennett, Charles W., October, 1906.
General Manager, Binghamton Gas Works, 40 Chenango Street, Binghamton, New York.

BENNETT, ORVILLE GRANT, March, 1914.
Assistant Treasurer, Northern Westchester Lighting Company, 127 Main Street, Ossining, New York.

BENSON, FREDERICK SHEPARD, JR., March, 1911.
Superintendent, Nassau Works, Brooklyn Union Gas Company, 556 Kent Avenue, Brooklyn, New York.

BENTON, ALBERT LEE, September, 1915.
Superintendent, Lockport Light, Heat & Power Company, Olean, New York.

BERKLEY, JOS. M., October, 1906.
Superintendent and Engineer, Southern California Edison Company, Edison Building, Los Angeles, California.

BERTKE, W. A., September, 1909.
Superintendent, Gas Plants, Pacific Power & Light Company, North Yakima, Washington.

BERTKE, WILLIAM JOHN, October, 1907.
Engineer, Sioux City Gas & Electric Company, 3519 Jackson Street, Sioux City, Iowa.

BERTRAND, PHILIP A., October, 1906.
General Manager, Grays Harbor Railway & Light Company, Electric Building, Aberdeen, Washington.

BESSON, WILLIAM C., March, 1915.
Treasurer, New York Mutual Gas Light Co., 36 Union Square, New York, New York.

BEUGLER, HUGH M., September, 1913.
Operating Manager, Central Hudson Gas & Electric Company, 50 Market Street, Poughkeepsie, New York.

BILL, BENJAMIN P., October, 1906.
Superintendent, Springfield Gas Light Company, 23 State Street, Springfield, Massachusetts.

BIMSON, JOHN, JR., September, 1909.
Superintendent Distribution, Public Service Gas Company, East 5th Street, Paterson, New Jersey.

BIRD, VIGGO EDWARD, September, 1910.
Manager, New London Gas & Electric Division, Connecticut Power Company, 33 Union Street, New London, Connecticut.

BISHOP, ROOKWOOD COMFORT, March, 1911.
General Manager, Christchurch Gas, Coal & Coke Company, Ltd., 77 Worcester Street, Christchurch, New Zealand.

BISSELL, WEST, October, 1906.
Civil Engineer, Care of Mrs. Kennedy, 27 Park Street, Jersey City, New Jersey.

Blackie, John F., March, 1911.
Assistant Superintendent, Milwaukee Coke & Gas Company, Milwaukee, Wisconsin.

Blackwell, Hubert C., September, 1912.
General Superintendent, Peoples Light Company, 125 West 3d Street, Davenport, Iowa.

Blauvelt, William Hutton, March, 1911.
Consulting Engineer, Semet-Solvay Company, 1917 West Genesee Street, Syracuse, New York.

Blauvelt, Warren S., October, 1906.
Superintendent, Detroit Plant, Delray Station, Semet-Solvay Company, West Jefferson and Solvay Avenues, Detroit, Michigan.

Blowers, Frank W., October, 1906.
Vice-President and General Manager, Kalamazoo Gas Company, Kalamazoo, Michigan.

Boardman, A. E., October, 1906.
Villa Canto Sereno, Locarno, Minusio, Switzerland.

Bodine, Samuel Taylor, October, 1906.
President, The United Gas Improvement Company, Broad and Arch Streets, Philadelphia, Pennsylvania.

Bond, Charles O., March, 1907. (P)
Manager, Photometrical Laboratory, The United Gas Improvement Company, 3101 Passyunk Avenue, Philadelphia, Pennsylvania.

Boone, Charles, October, 1906.
Engineer, Metropolitan Works, Brooklyn Union Gas Company, 12th Street and Gowanus Canal, Brooklyn, New York.

Booth, Arthur, September, 1909.
Assistant General Purchasing Agent, Philadelphia Company, 435 Sixth Avenue, Pittsburgh, Pennsylvania.

Booth, W. F., March, 1909.
Manager, Little Rock Gas & Fuel Company, 113 West 6th Street, Little Rock, Arkansas.

Borden, Albert Wells, September, 1914.
Vice-President and Manager, The Hastings Gas Company, 302 Lincoln Avenue, Hastings, Nebraska.

Borgner, Cyrus, October, 1906.
President, Cyrus Borgner Company, 234 North Twenty-third Street, Philadelphia, Pennsylvania.

BOYD, ALBERT MATTHEW, October, 1906.
Assistant to General Superintendent, United Gas Improvement Company, 1401 Arch Street, Philadelphia, Pennsylvania.

BRADLEY, CHARLES W., October, 1906.
Gas Engineer, Public Service Company of Northern Illinois, 72 West Adams Street, Chicago, Illinois.

BRADLEY, WALLACE H., September, 1914.
Manager, Springfield Gas Light Company, State and Water Streets, Springfield, Massachusetts.

BRADLEY, WILLIAM H., October, 1906.
Chief Engineer, Consolidated Gas Company of New York, 130 East 15th Street, New York, New York.

BRADY, JAMES C., March, 1907.
Director, New Amsterdam Gas Company, 54 Wall Street, New York, New York.

BRAINE, JOHN H., October, 1906.
Superintendent, Holder Distribution Department, Brooklyn Union Gas Company, 176 Remsen Street, Brooklyn, New York.

BREWER, JOSEPH H., September, 1912.
Vice-President, Kelsey & Brewer Company, Michigan Trust Building, Grand Rapids, Michigan.

BRITSCH, MATHIAS, October, 1906.
Superintendent, Cicero Station, Public Service Company of Northern Illinois, Lombard Avenue and G. W. Tracks, Oak Park, Illinois.

BRITTON, JOHN A., October, 1906. (P)
Vice-President and General Manager, Pacific Gas & Electric Company, 445 Sutter Street, San Francisco, California.

BRITTON, JOHN A., JR., March, 1915. (P)
Assistant Engineer, Gas Department, Pacific Gas & Electric Company, 13th and Clay Streets, Oakland, California.

BRITTON, VAN LEER EASTLAND, September, 1914. (P)
Assistant Engineer, Gas Department, Pacific Gas & Electric Company, 7th and Market Streets, San Francisco, California.

BRODNAX, WM. F., October, 1907.
14 Eighth Avenue, Bethlehem, Pennsylvania.

BROWN, CHARLES H., September, 1912.
Superintendent, Suffolk Gas-Electric Company, 1003 West Washington Street, Suffolk, Virginia.

Brown, Ernest C., October, 1906.
Secretary and Treasurer, Boone (Iowa) Gas Company, Editor *The Gas Age,* 52 Vanderbilt Avenue, New York, New York.

Brown, James A., September, 1911.
Gas Engineer, Consumers Power Company, 214 West Main Street, Jackson, Michigan.

Brown, R. B., October, 1906.
General Manager and Chief Engineer, Milwaukee Gas Light Company, 182 Wisconsin Street, Milwaukee, Wisconsin.

Brown, Robert E., October, 1906.
General Manager, Consumers Power Company, 132 South Front Street, Mankato, Minnesota.

Brown, Samuel W., September, 1910.
Superintendent, Gas Department, Columbia Railway, Gas & Electric Company, 2805 Wilson Street, Columbia, South Carolina.

Bruce, Howard, October, 1906.
Vice-President, The Bartlett Hayward Company, Continental Building, Baltimore, Maryland.

Bruff, Charles L., March, 1911.
Combustion Engineer, United Gas Improvement Company, 1401 Arch Street, Philadelphia, Pennsylvania.

Brundage, Henry M., September, 1908.
Assistant Secretary, Consolidated Gas Company of New York, 130 East 15th Street, New York, New York.

Brundrett, Ernest L., October, 1906.
President, Kansas City Gas Company, 910 Grand Avenue, Kansas City, Missouri.

Brush, Daniel Harmon, Jr., March, 1912.
Superintendent, Calumet Division, Peoples Gas Light & Coke Company, 9555 Houston Avenue, Chicago, Illinois.

Bryans, Henry Bussell, March, 1908.
Engineer, Counties Gas & Electric Company, Norristown, Pa.

Bryant, Charles F., October, 1906.
Auditor, Westchester Lighting Company, 1st Avenue and 1st Street, Mount Vernon, New York.

Buchanan, Paul R., September, 1915.
Superintendent, Hartford City Gas Light Company, 565 Main Street, Hartford, Connecticut.

Buckley, Martin F., March, 1913.
Foreman, Consolidated Gas Company, 501 East 21st Street, New York, New York.

Buckminster, Rollin, September, 1908.
Manager, Commercial Department, Fall River Gas Works Company, Fall River, Massachusetts.

Bull, David M., September, 1913.
Assistant Superintendent, Consolidated Gas Company, 99th Street and 2nd Avenue, New York, New York.

Bullard, John Ervin, March, 1913.
Manager, New Business Department, Public Service Corporation of Long Island, Port Washington, New York.

Bunker, Theodore, October, 1906.
Engineer, Gas Department, Passaic Division, Public Service Gas Company, East 5th Street Gas Works, Paterson, New Jersey.

Burcombe, Norman Smith, March, 1911. (P)
Manager, Grays Harbor Gas Company, 210 South Broadway, Aberdeen, Washington.

Burgi, Herman, October, 1906.
General Superintendent, Gas Light Company, State and Water Streets, Springfield, Massachusetts.

Burke, John Edward, March, 1914.
Superintendent of Distribution, Buffalo Gas Company, 249 West Genesee Street, Buffalo, New York.

Burkhart, Henry W., March, 1910. (P)
Consulting Gas Engineer, 913 International Bank Building, Los Angeles, California.

Burleigh, John J., September, 1907.
Second Vice-President, Public Service Gas Company, 418 Federal Street, Camden, New Jersey.

Burns, John J., March, 1914. (P)
Superintendent, Commercial Department, Laclede Gas Light Company, 11th and Olive Streets, St. Louis, Missouri.

Burritt, Dwight F., September, 1907.
General Superintendent, National Gas, Electric Light & Power Company, 1714 Ford Building, Detroit, Michigan.

Burt, Austin, October, 1906.
Manager, Citizens Gas & Electric Company, 308 East 4th Street, Waterloo, Iowa.

Bush, Robert Wilder, October, 1906.
Engineer of Manufacture, Brooklyn Union Gas Company, 176 Remsen Street, Brooklyn, New York.

Butler, John Morris, September, 1913.
Secretary and Treasurer, Bronx Gas & Electric Company, Westchester, New York.

Butterworth, C. W., October, 1906.
Care Gas Company, Rockford, Illinois.

Byrne, Edward J., October, 1906.
Engineer of Citizens Works, Brooklyn Union Gas Company, 176 Remsen Street, Brooklyn, New York.

Byrne, Edward Louis, September, 1910.
Superintendent, Fulton Works, The Brooklyn Union Gas Company, 265 Nevins Street, Brooklyn, New York.

Byrne, Thomas E., October, 1906.
Chief Engineer and General Manager, Kings County Lighting Company, 4802 New Utrecht Avenue, Brooklyn, New York.

Cabell, John L., September, 1908.
Cabell & Peek, 120 Bay Street East, Savannah, Georgia.

Cabot, John, October, 1906.
1512 Grand Street, Hoboken, New Jersey.

Cadwallader, L. L., October, 1906.
Superintendent, Kennebec Gas & Fuel Company, Waterville, Maine.

Caffrey, George Henry, March, 1913.
With Gas & Electric Company, Abilene, Texas.

Cahill, William J., October, 1906.
General Manager, Gas Department, Utica Gas & Electric Company, 222 Genesee Street, Utica, New York.

Caldwell, John D., March, 1915.
Superintendent, Asheville Power & Light Company, Asheville, North Carolina.

Calhoun, Ervin, September, 1913.
Superintendent of Stores, Philadelphia Gas Works, United Gas Improvement Company, 19th Street and Allegheny Avenue, Philadelphia, Pennsylvania.

Calkins, William Bartlett, March, 1914.
Chemist, Fuel Testing Company, 220 Devonshire Street, Boston, Massachusetts.

Callenbach, Dr. J. Anton, October, 1906.
Chemical Engineer, Clinchfield Fuel Company, 134 St. John Street, Spartanburg, South Carolina.

Callender, Elbert P., October, 1906.
President, *American Gas Light Journal,* Inc., 42 Pine Street, New York, New York.

Campbell, Alex. J., October, 1906.
General Manager, United Electric Light & Water Company, Waterbury, Connecticut.

Campbell, S. K., October, 1906.
Editor, *American Gas Light Journal,* Inc., 42 Pine Street, New York, New York.

Carbonell, Cornelius M., September, 1913.
Assistant Secretary, Astoria Light, Heat & Power Company, 130 East 15th Street, New York, New York.

Carnes, Frank S., September, 1908.
Superintendent, South Division Street Department, Peoples Gas Light & Coke Company, 38 West 64th Street, Chicago, Illinois.

Carpenter, Harold, September, 1907.
Resident Engineer, Astoria Tunnel, The Astoria Light, Heat & Power Company, 977 Whitlock Avenue, New York, New York.

Carroll, Lafayette D., September, 1908.
Mechanical Engineer, 38 Victoria Street, London, S. W., England.

Carson, George S., October, 1906.
President, Iowa Gas & Electric Company, Washington, Iowa.

Carson, Hiram J., September, 1915.
General Manager, Cedar Rapids Gas Light Co., Cedar Rapids, Iowa.

Carter, Robert A., September, 1907.
Vice-President, Consolidated Gas Company of New York, 130 East 15th Street, New York, New York.

Carter, Robert A., Jr., September, 1908. (P)
Assistant to Engineer of Manufacture, Consolidated Gas Company, 130 East 15th Street, New York, New York.

Castor, William A., October, 1906.
Superintendent of Meters, United Gas Improvement Company, 30 East Tulpehocken Street, Philadelphia, Pennsylvania.

Cathels, Edmund, October, 1906.
Engineer, 28 Plain Street, Providence, Rhode Island.

Causebrook, W. R., September, 1907.
Agent, Gas and Electric Departments, Public Service Gas Company, 210 Park Avenue, Plainfield, New Jersey.

Chadwell, William H., September, 1907.
Superintendent, Market Street Gas Works, Public Service Gas Company, Newark, New Jersey.

Chamberlain, Glenn R., October, 1906.
Secretary and Manager, Commercial Department, Grand Rapids Gas Light Company, Pearl and Ottawa Streets, Grand Rapids, Michigan.

Channon, Harry O., March, 1911.
Manager, Quincy Gas, Electric & Heat Company, 422 Main Street, Quincy, Illinois.

Chapin, C. H. B., September, 1913.
Secretary, Empire State Gas & Electric Association, 29 West 39th Street, New York, New York.

Chapman, Harlen Monroe, September, 1913.
Superintendent, Semet-Solvay Company, Indianapolis, Indiana.

Cheney, Herbert Neal, March, 1911.
Engineer of Construction, Boston Consolidated Gas Company, 24 West Street, Boston, Massachusetts.

Cheney, Seymour Wyatt, March, 1914.
Assistant Engineer, American Public Utilities Company, Michigan Trust Building, Grand Rapids, Michigan.

Chewning, Walter L., September, 1907.
Engineering Department, United Gas Improvement Company, 1401 Arch Street, Philadelphia, Pennsylvania.

Chichester, Alfred A., October, 1906.
Superintendent, North Division Street Department, Peoples Gas Light & Coke Company, 634 Hobbie Street, Chicago, Illinois.

Chubb, Chester N., October, 1906.
Manager, Northern Indiana Gas & Electric Company, 215 South Michigan Street, South Bend, Indiana.

Chubbuck, H. E., October, 1906.
Vice-President Executive, Illinois Traction System, Peoria, Illinois.

Clabaugh, G. W., October, 1906.
Vice-President and Secretary, Omaha Gas Company, 1509 Howard Street, Omaha, Nebraska.

Clark, Horace Herbert, March, 1910. (P)
Engineer of Gas Distribution, Public Service Company of Northern Illinois, 72 West Adams Street, Chicago, Illinois.

Clark, John A., Jr., October, 1906.
Engineer of Distribution, Public Service Gas Company, 35 Front Street, Newark, New Jersey.

Clark, John C. D., October, 1906.
Salt Lake City, Utah.

Clark, Robert Browning, March, 1911.
Superintendent of Works, Fall River Gas Works Company, 512 High Street, Fall River, Massachusetts.

Clark, Walton, October, 1906.
Second Vice-President, The United Gas Improvement Company, Broad and Arch Streets, Philadelphia, Pennsylvania.

Clark, William J., October, 1906.
Vice-President, Westchester Lighting Company, 1st Avenue and 1st Street, Mount Vernon, New York.

Clark, W. Van Alan, March, 1912.
With Brooklyn Union Gas Company, Foot North 12th Street, Brooklyn, New York.

Clarke, Alfred, March, 1908.
President, Various Gas Companies, 131 State Street, Boston, Massachusetts.

Clary, Edward D., October, 1906.
Superintendent, Burlington Gas Light Company, 3d and Washington Streets, Burlington, Iowa.

Clausen, William F., October, 1906.
General Manager, Wisconsin-Minnesota Light & Power Company, Winona, Minnesota.

Cline, W. B., October, 1906. (P)
President and General Manager, Los Angeles Gas & Electric Corporation, 645 South Hill Street, Los Angeles, California.

Coate, P. S., October, 1906.
Manager and Secretary-Treasurer, Chatham Gas Company, Limited, King Street, West, Chatham, Ontario, Canada.

Cobb, B. C., October, 1906.
President, Kalamazoo Gas Company; Hodenpyl, Hardy & Co., 14 Wall Street, New York, New York.

Cobb, S. P., October, 1906.
Raleigh, North Carolina.

Cocke, J. Bowdoin, March, 1914.
Gas Engineer, Superintendent Gas Department, Rocky Mount Public Works, Rocky Mount, North Carolina.

Cohn, Chas. M., September, 1907.
First Vice-President, Consolidated Gas, Electric Light & Power Company, 100 West Lexington Street, Baltimore, Maryland.

Cole, C. M., October, 1906.
With Syracuse Lighting Company, Syracuse, New York.

Cole, George M., October, 1906.
Vice-President and Manager, Plattsburgh Gas & Electric Company, 30 Margaret Street, Plattsburgh, New York.

Cole, William W., October, 1906.
Consulting Engineer, 43 Exchange Place, New York, New York.

Coleman, Walter Ceely, March, 1914.
Secretary and Treasurer, Troy Gas Company, Troy, New York.

Collin, H. M., September, 1912.
General Manager, Glenns Falls Gas & Electric Light Company, 11 Warren Street, Glenns Falls, New York.

Collins, Carroll, October, 1906. (P)
President, Treasurer and Manager, Marshall Gas Light Company, East State Street, Marshall, Michigan.

Collins, David J., October, 1906.
Sales Agent, The United Gas Improvement Company, Broad and Arch Streets, Philadelphia, Pennsylvania.

Collins, J. Clarence, September, 1909.
Secretary and Auditor, Rochester Railway & Light Company, 34 Clinton Avenue North, Rochester, New York.

Collins, Johnston E., March, 1915.
Superintendent, Station A, Detroit City Gas Company, Detroit, Michigan.

Colquhoun, Edward M., September, 1908.
Travelling New Business Agent, The United Gas Improvement Company, 1401 Arch Street, Philadelphia, Pennsylvania.

Colvin, J. E., October, 1906.
Superintendent, Muncie Gas Light & Fuel Company, 301 East Main Street, Muncie, Indiana.

Combs, Roger B., October, 1906.
General Manager, Nashville Gas & Heating Company, 611 Church Street, Nashville, Tennessee.

Comstock, C. A., March, 1911.
Watertown, Wisconsin.

Congdon, Richard C., October, 1906.
Secretary and General Manager, Atlanta Gas Light Company, Electric & Gas Building, Atlanta, Georgia.

Conlee, George D., September, 1913.
Superintendent, Chuctanunda Gas Light Company, 33 Market Street, Amsterdam, New York.

Conners, Mathias, October, 1906.
Superintendent, Peoples Gas Light & Coke Company, 31st Street and Pitney Court, Chicago, Illinois.

Conover, Ernest R., September, 1913.
Superintendent, Westchester Lighting Company, 7 West Main Street, Tarrytown, New York.

Cook, Chas. G., September, 1907.
Agent, Gas and Electric Departments, Public Service Gas Company, 222 East State Street, Trenton, New Jersey.

Cook, Henry R., Jr., September, 1907.
Assistant to General Superintendent, United Gas Improvement Company, 1401 Arch Street, Philadelphia, Pennsylvania.

Cooper, Wm. H., October, 1906.
Vice-President, Chuctanunda Gas Light Company, 96 Church Street, Amsterdam, New York.

Copley, Hon. Ira C., October, 1906.
President, Western United Gas & Electric Company, Aurora, Illinois.

Cornine, Marshall, March, 1911.
Superintendent, Repair Shops, Consolidated Gas Company, 111th Street and 1st Avenue, New York, New York.

Cornish, R. C., October, 1906.
Engineer, American Gas Company, West Washington Square, Philadelphia, Pennsylvania.

Corscot, John, October, 1906.
Vice-President, Madison Gas & Electric Company, 126 East Main Street, Madison, Wisconsin.

Cortelyou, George B., March, 1912.
President, Consolidated Gas Company of New York, 130 East 15th Street, New York, New York.

Covert, Ira C., September, 1907.
Manager, Billings Gas Company, Billings, Montana.

Cowdery, Edward G., October, 1906. (P)
President, Peoples Gas Light & Coke Company, Peoples Gas Building, Chicago, Illinois.

Cowperthwait, B. W., October, 1906.
Manager, Consumers Power Company, Central Avenue, Faribault, Minnesota.

Cowperthwait, George E., September, 1912.
Secretary, Danbury & Bethel Gas & Electric Light Company, 238 Main Street, Danbury, Connecticut.

Crafts, Harry C., October, 1906.
Manager, Pittsfield Coal Gas Company, 30 South Street, Pittsfield, Massachusetts.

Crahan, B. J., October, 1906.
Superintendent, Joplin Gas Company, 318 Joplin Street, Joplin, Missouri.

Crane, William M., October, 1906. (P)
President, Wm. M. Crane Company, 20 West 32d Street, New York, New York.

Crawford, Thomas, March, 1907.
General Manager, Clinton Gas Light & Coke Company, Clinton, Iowa.

Creighton, John Thomas, March, 1913.
Superintendent Gas Manufacture, Los Angeles Gas & Electric Corporation, 553 Ramirez Street, Los Angeles, California.

Cressey, Frank A., Jr., September, 1912. (P)
Manager, Modesto Gas Light, Coal & Coke Company, 818 Tenth Street, Modesto, California.

Cressler, A. D., October, 1906.
President, The Kerr Murray Company, 1708 North Collins Street, Joliet, Illinois.

Cresson, B. F., October, 1906.
President, Easton Gas & Electric Company, 2d and Ferry Streets, Easton, Pennsylvania.

Crighton, D. K., October, 1906.
Engineer, Gas Machinery Company, 1900 Euclid Avenue, Cleveland, Ohio.

Crilly, Roger, October, 1906.
General Foreman, Elizabethtown Gas Light Company, 19 Loomis Street, Elizabeth, New Jersey.

Crisfield, J. A. P., October, 1906.
Engineer, The United Gas Improvement Company, 1401 Arch Street, Philadelphia, Pennsylvania.

Cross, Charles Alfred, March, 1911.
Engineer, Williamsburgh Works, Brooklyn Union Gas Company, foot of North 12th Street, Brooklyn, New York.

Cross, Frank L., March, 1909.
General Manager, Madison Gas & Electric Company, 1020 Sherman Avenue, Madison, Wisconsin.

Cross, Philip, October, 1906.
Superintendent, New Business Department, Fuel Appliances, Consolidated Gas Company, 130 East 15th Street, New York, New York.

Croston, William F., March, 1914.
Superintendent, Gas Department, Newport News & Hampton Railway, Gas & Electric Company, Newport News, Virginia.

Crowell, F. B., October, 1906.
Consulting and Contracting Engineer, Post Office Box 1006, St. Petersburg, Florida.

Crowley, John P., October, 1906.
Secretary and Treasurer, St. Paul Gas Light Company, St. Paul, Minnesota.

Crutcher, William H., September, 1911.
Superintendent, Gas Department, Louisville Gas & Electric Company, 201 Starks Building, Louisville, Kentucky.

Curran, G. W., October, 1906.
Secretary, The United Gas Improvement Company, Broad and Arch Streets, Philadelphia, Pennsylvania.

Curtis, George W., September, 1907.
Superintendent, Camden Coke Works, Gas Department, Camden, New Jersey.

Curtis, Samuel P., October, 1906.
General Manager, American Gas Company, West Washington Square, Philadelphia, Pennsylvania.

Cushman, Charles P., March, 1909.
First Vice-President, Osaka Gas Company, Limited, Osaka, Japan.

Cutcheon, Fredk. Richard M., March, 1913.
General Manager, Consolidated Gas Company of New Jersey, 176 Broadway, Long Branch, New Jersey.

Daily, James Madison, March, 1913.
General Manager, Pueblo Gas & Fuel Company, 514 North Main Street, Pueblo, Colorado.

Dallas, Robert E., September, 1908.
Philadelphia, Pennsylvania.

DALY, AUGUSTIN J., October, 1906.
Superintendent City District, Laclede Gas Light Company, 2655 Adams Street, St. Louis, Missouri.

DANFORTH, BYRON HAMILTON, March, 1913.
Galesburg, Illinois.

DASHIELL, P. T., October, 1906.
Assistant Engineer of Works, United Gas Improvement Company, 1401 Arch Street, Philadelphia, Pennsylvania.

DAUGHERTY, GEORGE, October, 1906.
General Manager, Trumbull Public Service Company, 409 Adams Street, Warren, Ohio.

DAVIES, CALEB, JR., September, 1915.
Superintendent, By-Products Coke Works, Republic Iron & Steel Co., 1811 Elm Street, Youngstown, Ohio.

DAVIES, EDWARD LIVINGSTON, September, 1912.
Gas Superintendent, Queens Boro Gas & Electric Company, 347 Central Avenue, Far Rockaway, L. I., New York.

DAVIES, H. W., October, 1906.
Representative, Safety Car Heating & Lighting Company, 501 Commercial Trust Building, Philadelphia, Pennsylvania.

DAVIES, JAMES E., September, 1908.
Division Superintendent and Manager, Calumet Division, Peoples Gas Light & Coke Company, 9051 Commercial Avenue, Chicago, Illinois.

DAVIS, ALBERT G., March, 1911.
Chemist, Consolidated Gas Company, 435 6th Avenue, Pittsburgh, Pennsylvania.

DAVIS, ERNEST H., October, 1906.
Treasurer, Northern Central Gas Company, Lewistown, Pennsylvania, West and Willow Streets, Williamsport, Pennsylvania.

DAVIS, GEORGE H., September, 1912.
Member of firm Ford, Bacon & Davis, Engineers, 921 Canal Street, New Orleans, Louisiana.

DAVIS, R. N., March, 1907.
Assistant Superintendent, care Peoples Gas Light & Coke Company, 122 South Michigan Avenue, Chicago, Illinois.

DAWES, HENRY M., March, 1914.
President, Southwestern Gas & Electric Company, 111 West Monroe Street, Chicago, Illinois.

DAWES, RUFUS C., October, 1906.
President, Mobile (Alabama) Gas Company, 111 West Monroe Street, Chicago, Illinois.

DAY, ADDISON BLANCHARD, March, 1913. (P)
Manager of Operation, Los Angeles Gas & Electric Corporation, 645 South Hill Street, Los Angeles, California.

DAY, C. L., October, 1906.
General Superintendent, Street and Meter Department, Peoples Gas Light & Coke Company, 122 South Michigan Avenue, Chicago, Illinois.

DE CASTRO, JOSEPH L., September, 1911.
Assistant Superintendent, Consolidated Gas Company, foot of East 115th Street, New York, New York.

DEFREITAS, WILLIAM, March, 1910.
Assistant Superintendent, Appliance Department, Consolidated Gas Company, 130 East 15th Street, New York, New York.

DE FRESE, S. E., March, 1914.
General Manager, Chattanooga Gas Company, 926 Market Street, Chattanooga, Tennessee.

DELL, JOHN, October, 1906.
President, Missouri Fire Brick Company, 411 Olive Street, St. Louis, Missouri.

DELONG, JAMES C., September, 1908. (P)
President, Syracuse Lighting Company, 335 South Warren Street, Syracuse, New York.

DEQUINE, LOUIS EDWARD, September, 1914.
General Superintendent, Consolidated Gas Company of New Jersey, 55 Slocum Place, Long Branch, New Jersey.

DE VOE, FREDERICK R., March, 1913.
Secretary and Treasurer, Northern Union Gas Company, 1815 Webster Avenue, Bronx, New York, New York.

DEWEY, FRED SUMNER, September, 1915.
General Superintendent, Muscatine Lighting Company, Muscatine, Iowa.

DEWEY, V. F., October, 1906.
General Manager, Detroit City Gas Company, Gas Office Building, Detroit, Michigan.

DEXTER, MACDOUGALD, October, 1906.
Superintendent, Gas Light Company of Columbus, 1151 Broad Street, Columbus, Georgia.

Dickey, Charles H., October, 1906. (P)
Charles H. Dickey & Company, Guilford Avenue and Saratoga Street, Baltimore, Maryland.

Dickey, E. D. V., March, 1909.
Manager, Freeport Gas Company, 156 Stephenson Street, Freeport, Illinois.

Dickey, Samuel J., March, 1908.
Engineer, Gas Department, Syracuse Lighting Company, 335 South Warren Street, Syracuse, New York.

Dieterle, Edward A., March, 1908.
Chemist, Seattle Lighting Company, Seattle, Washington.

Dillon, Harry J., September, 1911.
Superintendent, Brooklyn Borough Gas Company, Coney Island, New York.

Dixon, J. Alfred, October, 1906.
Vice-President and Manager, Pintsch Compressing Company, 2 Rector Street, New York, New York.

Dixon, R. M., October, 1906.
Vice-President, Pintsch Compressing Company, 2 Rector Street, New York, New York.

Doane, George W., September, 1910.
President, New Amsterdam Gas Company, 22 East 22d Street, New York, New York.

Doherty, Henry L., October, 1906.
Chairman of Board, Denver Gas & Electric Light Company, 60 Wall Street, New York, New York.

Dole, Walter S., October, 1906.
Chief Engineer, Santa Monica Water Company, 1400 Second Street, Santa Monica, California.

Donahue, E. J., October, 1906.
Engineer, Hudson Division, Public Service Gas Company, St. Paul and St. James Avenues, Jersey City, New Jersey.

Dorner, William F., October, 1906.
Superintendent, 25th Ward Gas Works, United Gas Improvement Company, Richmond and Tioga Streets, Philadelphia, Pennsylvania.

Dorr, William J., September, 1907.
Superintendent of Gas Distribution, Los Angeles Gas & Electric Corporation, 645 South Hill Street, Los Angeles, California.

DOTY, PAUL, October, 1906.
Vice-President and General Manager, St. Paul Gas Light Company, 159 East Sixth Street, St. Paul, Minnesota.

DOUGHERTY, BENJAMIN R., October, 1906.
Superintendent, Richmond Water & Light Company, Richmond, Kentucky.

DOUGLAS, HENRY W., October, 1906. (P)
Manager, Ann Arbor Gas Company, 211 East Huron Street, Ann Arbor, Michigan.

DOUGLAS, JAMES B., September, 1909.
Manager, Claim Department, United Gas Improvement Company, 1401 Arch Street, Philadelphia, Pennsylvania.

DOUTHIRT, W. F., October, 1906.
Fourth Vice-President, The United Gas Improvement Company, Broad and Arch Streets, Philadelphia, Pennsylvania.

DOW, FRED N., March, 1914.
President, Portland Gas Light Company, Box 668, Portland, Maine.

DOWN, FREDERICK J., March, 1910.
Superintendent, 42d Street Station, Consolidated Gas Company, Foot West 42d Street, New York, New York.

DOWNEY, JAMES N., September, 1907.
Assistant Superintendent, Camden Coke Company, Camden, New Jersey.

DRAKE, FRANCIS EDWARD, September, 1914.
Manager, Gas Department, Lynn Gas & Electric Company, 90 Exchange Street, Lynn, Massachusetts.

DRUM, FRANK G., March, 1915. (P)
President, Pacific Gas & Electric Company, 354 Pine Street, San Francisco, California.

DUDLEY, A. D., March, 1908.
New Business Agent, Syracuse Lighting Company, Syracuse, New York.

DUGGAN, FRANK P., March, 1911.
Superintendent, Gas Department, Penn Central Light & Power Company, 31 West Market Street, Lewistown, Pennsylvania.

DUNBAR, JAMES W., October, 1906.
Assistant to President, United Gas & Electric Company, 138 East Spring Street, New Albany, Indiana.

Duncan, Ronald Bruce, September, 1911.
Superintendent, Spring Garden District, United Gas Improvement Company, 1615 North 9th Street, Philadelphia, Pennsylvania.

Dunn, F. S., October, 1906. (P)
Superintendent, Municipal Gas Company, 1131 Broadway, Albany, New York.

Dunne, Philip, October, 1906.
Night Superintendent, Consolidated Gas Company of New York, 558 West 170th Street, New York, New York.

Durkee, Charles C., September, 1909.
Superintendent, Pueblo Gas & Fuel Company, 811 West 18th Street, Pueblo, Colorado.

Dustin, Guy K., October, 1906.
48 Macon Street, Brooklyn, N. Y.

Dutter, H. O., October, 1906.
Manager, Bucyrus Telephone Company, Bucyrus, Ohio.

Dutton, Lewis R., October, 1906.
Division Manager, Jenkintown District, Philadelphia Suburban Gas & Electric Company, Wyncote, Pennsylvania.

Dutton, R. H., October, 1906.
Colmar, Pennsylvania.

Earnshaw, Edward H., October, 1906. (P)
Assistant General Manager, Public Service Gas Company, 759 Broad Street, Newark, New Jersey.

Eaton, Alfred B., October, 1906.
Vice-President, Sheboygan Gas Light Company, 1519 Peoples Gas Building, Chicago, Illinois.

Eaton, Cyrus S., September, 1914.
President and Manager, Continental Gas & Electric Corporation, Cuyahoga Building, Cleveland, Ohio.

Eaton, Homer M., March, 1910.
With W. E. Moss & Company, 710 Union Trust Building, Detroit, Michigan.

Eaton, James B., March, 1907.
Purchasing Agent, Rochester Railway & Light Company, 34 Clinton Avenue, North, Rochester, New York.

Eaton, W. M., October, 1906.
1834 Fourth Street, Jackson, Michigan.

Eavenson, William K., October, 1906.
Special Representative, Industrial Gas Appliance Laboratory, Consolidated Gas Company, 130 East 15th Street, New York, New York.

Eilbeck, A. B., October, 1906.
New York, New York.

Einstein, A. C., March, 1908.
Vice-President and General Manager, Union Electric Light & Power Company, 315 North 12th Street, St. Louis, Missouri.

Elbert, V. L., October, 1906.
General Manager, St. Joseph Gas Company, 8th and Francis Streets, St. Joseph, Missouri.

Elder, David, September, 1907.
Minnesota Steel Company, Duluth, Minnesota.

Elliott, Arthur H., October, 1906. (P)
Consulting Engineer-Chemist, 30 Church Street, New York, New York; 49 Whitestone Avenue, Flushing, New York.

Elliott, LaRue B., September, 1908.
Division Superintendent, North Division Street Department, Peoples Gas Light & Coke Company, 122 South Michigan Avenue, Chicago, Illinois.

Ellis, Harry, September, 1907.
Superintendent of Distribution, Public Service Gas Company, Front and Cherry Streets, Camden, New Jersey.

Ellis, John W., October, 1906.
President and Manager, Providence Gas Company, Turks Head Building, Providence, Rhode Island.

Elston, I. C., Jr., October, 1906.
Elston, Clifford & Company, 707 New York Life Building, 39 South LaSalle Street, Chicago, Illinois.

Ely, Seth Harrison, March, 1908.
Manager, Dover, Rockaway & Port Oram Gas Company, 49 North Sussex Street, Dover, New Jersey.

Engel, Francis, October, 1906.
Secretary, Elizabethtown Gas Light Company, 124 Broad Street, Elizabeth, New Jersey.

English, A. L., October, 1906.
Manager, Citizens Gas & Electric Company, 26 Pearl Street, Council Bluffs, Iowa.

Estberg, Howard C., September, 1911.
Engineer, Utah Gas & Coke Company, Salt Lake City, Utah.

Eustace, John H., October, 1906. (P)
Engineer, Peoples Gas Light & Coke Company, 122 South Michigan Avenue, Chicago, Illinois.

Evans, Charles D., March, 1911.
Division Superintendent, Philadelphia Company, 435 6th Avenue, Pittsburgh, Pennsylvania.

Evans, George B., October, 1906. (P)
Laclede Gas Light Company, 11th and Olive Streets, St. Louis, Missouri.

Evans, Owen Brooke, September, 1907. (P)
Superintendent, Experimental Plant, United Gas Improvement Company, 1401 Arch Street, Philadelphia, Pennsylvania.

Eves, Philmer, September, 1907.
Advertising Manager, New Haven Gas Light Company, 80 Crown Street, New Haven, Conn.

Ewing, Alonzo Prentiss, March, 1913.
Vice-President and General Manager, Highland Park State Bank, Penobscot Bank Building, Detroit, Michigan.

Eysenbach, E. E., October, 1906.
Tulsa, Oklahoma.

Fair, Campbell W., October, 1906.
President and Manager, Webster City Gas Company, Webster City, Iowa.

Fancher, Nathaniel C., March, 1910.
Superintendent of Manufacture, Seattle Lighting Company, Seattle, Washington.

Fenniman, John Roff, March, 1914.
Superintendent, Consolidated Gas Company, 1907 Amsterdam Avenue, New York, New York.

FERGUSON, B. B., October, 1906.
President and Superintendent, Portsmouth Gas Company, 512 High Street, Portsmouth, Virginia.

FERRIER, JAMES, October, 1906.
President, Rome Municipal Gas Company, 420 Broad Street, Rome, Georgia.

FERRIS, HERBERT H., October, 1906.
Engineer of Manufacture, Essex Division, Public Service Gas Company, 446 Market Street, Newark, New Jersey.

FIELD, ROY ALBRIGHT, October, 1906.
New Business Manager, National General Electric Light & Power Company, 1714 Ford Building, Detroit, Michigan.

FIRSTBROOK, HARRY, March, 1914.
Consumers Gas Company, 234 West Broadway, Princeton, Indiana.

FISHER, DAVID G., October, 1906.
202 Bechtel Building, Davenport, Iowa.

FISHER, HOWELL, March, 1911.
Assistant Superintendent, New England Gas & Coke Company, Everett, Massachusetts.

FITZ, ROBERT F., October, 1906. (P)
Consulting Engineer, Post Office Box 275, Los Angeles, California.

FITZGERALD, LEONARD, October, 1906.
Superintendent, Gas & Electric Department, Gary Heat, Light & Water Company, Broad and Fifth Avenue, Gary, Indiana.

FLOOK, WILLIAM M., March, 1908.
Assistant Secretary, Peoples Gas Light & Coke Company of Chicago, Illinois, 54 Wall Street, New York, New York.

FLOWERS, DEAN WILCOX, September, 1907.
General Superintendent, St. Paul Gas Light Company, 6th and Jackson Streets, St. Paul, Minnesota.

FLOY, HENRY, March, 1915.
Consulting Engineer, 165 Broadway, New York, New York.

FLOYD, JAMES R., October, 1906.
Assistant Treasurer, International Agricultural Corporation, 165 Broadway, New York, New York.

FOGG, OSCAR H., October, 1906.
Engineer of Utilization, Consolidated Gas Company of New York, 130 East 15th Street, New York, New York.

Folger, Oliver H., September, 1912.
Assistant Superintendent of Distribution, Public Service Gas Company, 40 Columbia Avenue, Passaic, New Jersey.

Folsom, Robert Morse, September, 1911.
Second Assistant Superintendent, New England Gas & Coke Company, Everett, Massachusetts.

Ford, A. H., October, 1906.
Birmingham, Alabama.

Forstall, Alfred E., October, 1906.
Consulting Engineer, Secretary Trustees Gas Educational Fund, 84 William Street, New York, New York.

Forstall, Walton, October, 1906. (P)
Assistant Engineer of Distribution, Philadelphia Gas Works, The United Gas Improvement Company, Broad and Arch Streets, Philadelphia, Pennsylvania.

Foshay, W. B., September, 1911.
Manager, Northwestern Electric Co., Portland, Oregon.

Fowler, Samuel J., October, 1906.
Treasurer and Agent, Charlestown Gas & Electric Company, 29 Main Street, Charlestown, Massachusetts.

Fox, Clifford S., October, 1906. (P)
Superintendent, East River Gas Company, Webster Avenue and East River, Long Island City, New York.

Francis, J. **Edward**, September, 1912.
Superintendent, Suffolk Gas-Electric Company, Suffolk, Virginia.

Francklyn, Charles G., March, 1911.
General Agent, Central Union Gas Company, 519 Courtlandt Avenue, New York, New York.

Francklyn, Gilbert, March, 1909.
Engineer of Distribution, Consolidated Gas Company of New York, 130 East 15th Street, New York, New York.

Frazer, D. H., October, 1906.
Treasurer and General Manager, Calhoun Gas Company, 26 East Main Street, Battle Creek, Michigan.

Freeman, Frederick Charles, September, 1910.
Engineer, The United Gas Improvement Company, 1401 Arch Street, Philadelphia, Pennsylvania.

Freese, Fred. W., October, 1906.
Gas Works Engineer and Contractor, Fort Wayne, Indiana.

Frick, John A., October, 1906.
Vice-President and General Manager, Allentown-Bethlehem Gas Company, 516 Hamilton Street, Allentown, Pennsylvania.

Frueauff, Frank W., October, 1906.
President, Denver Gas & Electric Light Company, H. L. Doherty & Company, 60 Wall Street, New York, New York.

Frueauff, Harry D., March, 1910.
Treasurer and General Manager, City Light & Traction Company, 404 South Ohio Street, Sedalia, Missouri.

Fulweiler, Walter Herbert, September, 1907.
Chemist, The United Gas Improvement Company, Broad and Arch Streets, Philadelphia, Pennsylvania.

Furlong, William G., March, 1911.
Secretary and Treasurer, Municipal Gas Company, 112 State Street, Albany, New York.

Gadsden, P. H., March, 1911.
President, Charleston Consolidated Railway & Lighting Company, Charleston, South Carolina.

Galloway, Edward William, March, 1913.
Assistant Engineer, Gas Department, Illinois Northern Utilities Company, Mendota, Illinois.

Galt, James Henry, September, 1913.
Superintendent of Works and Distribution, Public Service Gas Company, 147 East Hanover Street, Trenton, New Jersey.

Gannon, John J., October, 1906.
Superintendent and Agent, Vicksburg Gas Company, 707 Crawford Street, Vicksburg, Mississippi.

Ganser, Herbert H., October, 1906.
Manager, Counties Gas & Electric Company, 212 DeKalb Street, Norristown, Pennsylvania.

Ganz, Albert Frederick, September, 1913.
Consulting Engineer; Professor of Electrical Engineering, Stevens Institute of Technology, Hoboken, New Jersey.

Garrison, Ralph Howard, March, 1914.
General Superintendent, Standard Gas Company, Atlantic Highlands, New Jersey.

Gartland, C. C., October, 1906.
4082 East 76th Street, Cleveland, Ohio.

Gartley, William H., October, 1906.
Engineer of Philadelphia Gas Works, The United Gas Improvement Company, 1401 Arch Street, Philadelphia, Pennsylvania.

Gavit, E. Palmer, October, 1906.
90 State Street, Albany, New York.

Gawtry, Lewis B., September, 1908.
Vice-President, Consolidated Gas Company of New York, 130 East 15th Street, New York, New York.

Gefvert, Charles J., September, 1910.
Engineer's Assistant, Consolidated Gas Company, 130 East 15th Street, New York, New York.

Geist, Carlton, March, 1912.
General Manager, Atlantic City Gas Co., 2001 Atlantic Avenue, Atlantic City, New Jersey.

Geist, Clarence H., March, 1912.
President, Atlantic City Gas Company, 1127 Land Title Building, Philadelphia, Pennsylvania.

Genay, Thomas Bertram, October, 1906.
Superintendent of Manufacturing, Des Moines Gas Company, 412 West 7th Street, Des Moines, Iowa.

Genay, Thomas S., October, 1906.
Chief Clerk to Second Vice-President, The United Gas Improvement Company, 1401 Arch Street, Philadelphia, Pennsylvania.

Gerdenier, C. M., March, 1909.
Superintendent, Bridgeport Gas Light Company, 174 Arch Street, Bridgeport, Connecticut.

Gerould, Charles L., October, 1906.
Vernon Stiles Inn, Thompson, Connecticut.

Gifford, N. W., October, 1906.
General Manager, East Boston Gas Company, 26 Central Square, East Boston, Massachusetts.

Gilchrist, John Foster, September, 1914.
President, Missouri Gas & Electric Service Company, 72 West Adams Street, Chicago, Illinois.

Gill, John E., September, 1914.
President, The Manufacturers Light & Heat Company, 248 Fourth Avenue, Pittsburgh, Pennsylvania.

Gillett, Melville, October, 1906.
Director, Gas Companies, Smethport, Pennsylvania.

Gillingham, Hubert D., October, 1906.
Assistant Sales Manager, Public Service Gas Company, 759 Broad Street, Newark, New Jersey.

Gilpin, Francis Hopkinson, September, 1907.
Gas Engineer, The United Gas Improvement Company, 3101 Passyunk Avenue, Philadelphia, Pennsylvania.

Ginley, John, September, 1908.
Superintendent, Peoples Gas Light & Coke Company, 122 South Michigan Avenue, Chicago, Illinois.

Glasgow, Arthur Graham, October, 1906.
Humphreys & Glasgow, 36 Victoria Street, London, S. W., England.

Glass, Sheldon J., October, 1906.
Vice-President, Milwaukee Gas Light Company, 182 Wisconsin Street, Milwaukee, Wisconsin.

Goff, Ira Nathan, Jr., March, 1915.
Superintendent, Gas Works for the United States Government, West Point, New York.

Golden, John W., October, 1906.
Vice-President, Savannah Gas Company, 9 Congress Street, West, Savannah, Georgia.

Goodnow, George F., October, 1906.
General Manager, North Shore Gas Company, 213 North Genesee Street, Waukegan, Illinois.

Gordon, LeRoy O., March, 1913.
Manager, Valparaiso Lighting Company, 152 West Main Street, Valparaiso, Indiana.

Goudy, Roy Alonzo, March, 1914.
Manager, Petersburg Gas Company, 230 South Sycamore Street, Petersburg, Virginia.

Goudy, W. R., October, 1906.
With Williamson & Mead, 30 East 42d Street, New York, New York.

Gould, John A., October, 1906.
Engineer of Distribution, Boston Consolidated Gas Company, 24 West Street, Boston, Massachusetts.

Graeff, Harold W., October, 1906.
1513 North Thirty-third Street, Philadelphia, Pennsylvania.

Graf, Carl H., October, 1906.
Vice-President and General Manager, Municipal Gas Company, 112 State Street, Albany, New York.

Graham, Allan S., September, 1908.
Superintendent, Sioux Falls Gas Company, Sioux Falls, South Dakota.

Graham, Malcolm M., October, 1906.
Secretary and Treasurer, New Amsterdam Gas Company, 130 East 15th Street, New York, New York.

Grant, Robert, September, 1907.
Treasurer, Boston Consolidated Gas Company, 24 West Street, Boston, Massachusetts.

Graveley, Richard C., September, 1914.
Superintendent, Underground Construction, 19 West Broad Street, Bethlehem, Pennsylvania.

Greacen, W., **Jr.**, September, 1907.
Agent, Public Service Gas Company, 591 Spring Street, West Hoboken, New Jersey.

Gresham, Leonard G., September, 1915.
Superintendent of Lighting and Power, Lynchburg Traction & Light Company, 523 Main Street, Lynchburg, Virginia.

Grey, John Chester, September, 1908.
Superintendent, Savannah Gas Company, 9 Congress Street, West, Savannah, Georgia.

Gribbel, John, October, 1906.
President, Tampa (Florida) Gas Company, 1513 Race Street, Philadelphia, Pennsylvania.

Griswold, R. G., October, 1906. (P)
Gas Engineer, with H. L. Doherty & Company, 60 Wall Street, New York, New York.

Grover, Sherwood, March, 1915.
Assistant Gas Engineer, Pacific Gas & Electric Company, Grant Building, 7th and Market Streets, San Francisco, California.

Gruber, Charles A., September, 1912.
Manager, Saranac Lake Gas Company, 20 Main Street, Saranac Lake, New York.

Guffey, Joseph F., October, 1906.
General Manager, The Philadelphia Company, 435 Sixth Avenue, Pittsburgh, Pennsylvania.

Guldlin, Olaf N., October, 1906. (P)
President, Western Gas Construction Company, 2306 Fairfield Avenue, Fort Wayne, Indiana.

Gunn, Arthur, March, 1914.
President, Wenatchee Valley Gas & Electric Company, Wenatchee, Washington.

HAAG, F. E., March, 1909.
Auditor, Williamsport (Pa.) Gas Company, H. D. Walbridge & Company, 14 Wall Street, New York, New York.

HAASE, EWALD, October, 1906.
Secretary and Treasurer, Milwaukee Gas Light Company, 182 Wisconsin Street, Milwaukee, Wisconsin.

HACKSTAFF, JOHN DUDLEY, September, 1913. (P)
Consulting Engineer, Acacia Apartments, 10th and Alvarado Streets, Los Angeles, California.

HADDOCK, ISAAC T., September, 1913.
Chemist for Cambridge Gas Light Company, 354 Third Street, East Cambridge, Massachusetts.

HAFTENKAMP, JOSEPH P., September, 1907.
Assistant Superintendent, Rochester Railway & Light Company, 34 Clinton Avenue, North, Rochester, New York.

HAIGHT, THEODORE, March, 1911.
President, Plant Engineering & Equipment Company, Inc., 6 Church Street, New York, New York.

HAINES, JANSEN, October, 1906.
Manager, Des Moines Gas Company, 412 West 7th Street, Des Moines, Iowa.

HALL, A. H., October, 1906.
Assistant Secretary and Superintendent of Distribution, Central Union Gas Company, 519 Courtlandt Avenue, New York, New York.

HALL, ELMON LAWRENCE, September, 1912. (P)
Chief Engineer, Portland Gas & Coke Company, 292 Yamhill Street, Portland, Oregon.

HALSEY, WILLIAM M., March, 1909.
Agent, Public Service Gas Company, Gas and Electric Departments, 759 Broad Street, Newark, New Jersey.

HAMMATT, CLARENCE S., October, 1906.
Consulting Engineer, 1943 Main Street, Jacksonville, Florida.

HAMMON, WILLIAM H., October, 1906.
President, Hope Engineering & Supply Company, 902 Farmers Bank Building, Pittsburgh, Pennsylvania.

HAMMOND, WILBER M. R., March, 1912.
Comptroller, New York & Richmond Gas Company, 691 Bay Street, Stapleton, Staten Island, New York.

HANLAN, J. P., September, 1907.
Agent, New Business Department, Public Service Gas Company, Post Office Box 590, Newark, New Jersey.

HANTZMON, H. M., October, 1906.
Superintendent, City Gas Department, Charlotteville, Virginia.

Hardick, Charles F., October, 1906.
District Superintendent and Agent, The United Gas Improvement Company, 5961 Ridge Avenue, Philadelphia, Pennsylvania.

Hare, C. Willing, September, 1908. (P)
Manager, New Business Department, The United Gas Improvement Company, 1401 Arch Street, Philadelphia, Pennsylvania.

Hare, Joseph B., March, 1913.
Assistant Superintendent, Mains and Services, Central Union Gas Company, 519 Courtlandt Avenue, New York, New York.

Hargreaves, Robert H., September, 1912. (P)
Superintendent, Gas Works, Pacific Gas & Electric Company, 48 East San Antonio Street, San Jose, California.

Harlow, Justin Edwards, March, 1913.
Construction Engineer, Illinois Northern Utilities Company, 310 Peoria Avenue, Dixon, Illinois.

Harper, Robert Brinton, March, 1908. (P)
Superintendent of Testing Laboratories, Peoples Gas Light and Coke Company, 2501 Salt Street, Chicago, Illinois.

Harries, George Herbert, September, 1912.
President, Louisville Gas & Electric Company, 311 West Chestnut Street, Louisville, Kentucky.

Harriman, Horace Marshall, March, 1908.
General Superintendent, New Orleans Gas Light Company, 201 Baronne Street, New Orleans, Louisiana.

Harrington, Walter K., September, 1908.
Manager, The American Meter Company, 11th Avenue and 47th Street, New York, New York.

Harrison, George Morton, March, 1908.
Engineer, 1309 Rockland Street, Philadelphia, Pa.

Hart, Julian G., September, 1912.
Engineer, Gas Production, Public Service Company of Northern Illinois, 72 West Adams Street, Chicago, Illinois.

Hartman, William E., October, 1906.
Consulting Engineer, By-Products Coke Ovens, 327 South LaSalle Street, Chicago, Illinois.

Hathaway, E. C., October, 1906.
Assistant General Manager, Virginia Railway & Power Company, P. O. Box 1194, Norfolk, Virginia.

Haug, John Sobieski, September, 1914.
Assistant Engineer, Gas Department, Montreal Light, Heat & Power Company, 177 Harbour Street, Montreal, Canada.

Hawthorne, William James, September, 1908.
Superintendent, Water Gas Plant, Astoria Light, Heat & Power Company, Astoria, Long Island, New York.

HAYES, CLIFTON R., September, 1912.
Manager, Fitchburg Gas & Electric Light Company, 256 Main Street, Fitchburg, Massachusetts.

HAYES, WILLIAM PARSONS, March, 1914.
Supervisor of Building, Consolidated Gas Company of New York, 130 East 15th Street, New York, New York.

HEDGES, WILLIAM C., October, 1906.
Secretary and Treasurer, Mansfield Gas Light Company, 8 South Park Street, Mansfield, Ohio.

HELLEN, FRANK, March, 1907.
Superintendent, Gas Distribution Department, Rochester Railway & Light Company, 34 Clinton Avenue, North, Rochester, New York.

HELLEN, JOHN, October, 1906.
Superintendent of Distribution, Grand Rapids Gas Light Company, 109 North Ottawa Street, Grand Rapids, Michigan.

HELME, WILLIAM E., October, 1906.
Director several Gas Companies, 1339 Cherry Street, Philadelphia, Pennsylvania.

HELPS, GEORGE, September, 1913.
Civil Engineer, Engineer and Manager, Nuneaton Gas Company, Nuneaton, England.

HEMMINGER, GEORGE REVERDEY, September, 1908.
Engineer with The United Gas Improvement Company, Broad and Arch Streets, Philadelphia, Pennsylvania.

HENDERSON, SAMUEL W., September, 1912.
Vice-President and General Manager, Water, Gas & Electric Company, Excelsior Springs, Missouri.

HENDERSON, WILLIAM M., September, 1912. (P)
Assistant Gas Engineer, Pacific Gas & Electric Company, 445 Sutter Street, San Francisco, California.

HENDRICKSON, GEORGE S., March, 1914.
Superintendent's Assistant, Brooklyn Union Gas Company, 12th Street and Gowanus Canal, Brooklyn, New York.

HENOFER, J. P., March, 1909.
Superintendent, Holder Stations, Public Service Gas Company, St. Paul and St. James Avenues, Jersey City, New Jersey.

HERING, EDWARD, March, 1913.
Assistant to Chief Engineer, United States Cast Iron Pipe & Foundry Company, Burlington, New Jersey.

HEWITT, ARTHUR, September, 1910.
General Manager, Consumers Gas Company, 19 Toronto Street, Toronto, Ontario, Canada.

HILLEMEYER, JOSEPH E., March, 1910.
Engineer, St. Louis County Gas Company, Lockwood and McClure Avenues, Webster Groves, Missouri.

HIMSWORTH, HINES HORACE, March, 1914.
Superintendent's Assistant, Astoria Light, Heat & Power Company, Astoria, Long Island, New York.

HINE, WILLARD FOSTER, September, 1911.
Chief Gas Engineer, Public Service Commission for the First District, 154 Nassau Street, New York, New York.

HINMAN, CHARLES W., October, 1906.
Chemical Engineer, 10 Fenwick Road, Winchester, Massachusetts.

HINTZE, THOMAS HENRY, March, 1914.
Superintendent, Sassafras Point Station, Providence Gas Company, Providence, Rhode Island.

HIRST, HOMER T., September, 1910.
Assistant Superintendent, Street Department, Peoples Gas Light & Coke Company, 634 Hobbie Street, Chicago, Illinois.

HIRST, JESSE BOWMAN, September, 1910. (P)
Superintendent of Pressures, Peoples Gas Light & Coke Company, Peoples Gas Building, Chicago, Illinois.

HOCKENBEAMER, A. F., September, 1915. (P)
Vice-President and Treasurer, Pacific Gas & Electric Company, 445 Sutter Street, San Francisco, California.

HODGES, C. H., March, 1909.
Assistant Superintendent, Consolidated Gas Company of New York, 501 East 21st Street, New York, New York.

HOFFMAN, HOWARD, October, 1906.
Superintendent, Gas Department, Counties Gas & Electric Company, Ardmore, Pennsylvania.

HOFMANN, G. MAX, October, 1906.
General Superintendent, Fort Wayne Gas Company, Fort Wayne, Indiana.

HOFMANN, LOTHAR, October, 1906.
Assistant Engineer, Fort Wayne Gas Company, 2205 Broadway, Fort Wayne, Indiana.

HOLDEN, THOMAS F., October, 1906.
Superintendent of Works, Georgetown Gas Light Company, 218 Eighth Street, S. W., Washington, District of Columbia.

HOLMAN, C. L., October, 1906.
President and General Manager, The Laclede Gas Light Company, 11th and Olive Streets, St. Louis, Missouri.

HOLZER, EDWIN G., October, 1906.
Superintendent, Easton Gas & Electric Company, 349 Bushkill Street, Easton, Pennsylvania.

HONE, FREDERIC DEP., September, 1911.
Consulting Engineer, 1 Liberty Street, New York, New York.

HORNING, GEORGE R., September, 1908.
Manager, Macon Gas Company, 220 Second Street, Macon, Georgia.

HOUGH, DAVID LEAVITT, October, 1906.
President, United Engineering & Contracting Company, 17 West 42d Street, New York, New York.

HOUGHTON, CHARLES P., September, 1910. (P)
Second Vice-President, Los Angeles Gas & Electric Corporation, 645 South Hill Street, Los Angeles, California.

HOWARD, ABRAM C., October, 1906.
Gas Engineer, United Gas & Electric Engineering Corporation, 61 Broadway, New York, New York.

HOWARD, CHARLES A., September, 1906.
President, Aberdeen Gas Company, Aberdeen, South Dakota.

HOWLAND, LEWIS A., March, 1910.
General Superintendent, Queens Borough Gas & Electric Company, 345 Central Ave., Far Rockaway, New York.

HOY, CHAS. W., March, 1908.
Manager, New Jersey Gas Company, Glassboro, New Jersey.

HOYT, HARRY B., October, 1906.
General Manager, Jacksonville Gas Company, Church and Laura Streets, Jacksonville, Florida.

HOYT, WILLIAM G., October, 1906.
President, The Standard Gas Light Company, 130 East 15th Street, New York, New York.

HUBER, FRANK, October, 1906.
Citizens Trust Company, Jeffersonville, Indiana.

HUDDLE, WILEY JEROME, March, 1913.
Sloan, Huddle, Feustel & Freeman, Washington Building, Madison, Wisconsin.

HUDSON, DARWIN S., March, 1909.
Supervising Field Engineer, Construction Department, Consolidated Gas Company, 130 East 15th Street, New York, New York.

Huestis, Leon David, March, 1909.
Superintendent of Manufacture, Philadelphia Suburban Gas & Electric Company, 912 Highland Avenue, Chester, Pennsylvania.

Hulswit, Frank T., October, 1906.
President, United Light & Railway Company, 411 Michigan Trust Building, Grand Rapids, Michigan.

Hulswit, John A., March, 1912.
Treasurer, Grand Rapids Gas Light Company, Pearl and Ottawa Streets, Grand Rapids, Michigan.

Humphreys, Alexander C., October, 1906. (P)
President, Buffalo (N. Y.) Gas Company, and President, Humphreys & Miller, 165 Broadway, New York, New York.

Humphreys, C. J. R., October, 1906.
Vice-President and Agent, Lawrence Gas Company, 370 Essex Street, Lawrence, Massachusetts.

Humphreys, Frank Wilder, March, 1911.
In charge Gas Appliance Display Rooms, Consolidated Gas Company, 130 East 15th Street, New York, New York.

Humphreys, J. J., October, 1906.
Gas Engineer, Linderman Machine Company, Muskegon, Michigan.

Humphrys, Henry M., October, 1906.
Superintendent, West Side Works, Milwaukee Gas Light Company, 182 Wisconsin Street, Milwaukee, Wisconsin.

Hunt, H. R., October, 1906.
Division Superintendent, Peoples Gas Light & Coke Company, 25th and Loomis Streets, Chicago, Illinois.

Hunter, Chas. W., September, 1909.
Gas Engineer, with Stone & Webster Engineering Corporation, 147 Milk Street, Boston, Massachusetts.

Hunter, James F., March, 1909.
Assistant Engineer of Construction, Consolidated Gas Company of New York, 130 East 15th Street, New York, New York.

Hurlburt, A., October 1906.
Engineer, Kansas City Gas Company, 910 Grand Avenue, Kansas City, Missouri.

Hutchings, James T., September, 1907.
General Manager, Rochester Railway & Light Company, 34 Clinton Avenue, North, Rochester, New York.

Hutchinson, Frank R., October, 1906.
Automatic Draft Regulator Company, 452 East 105th Street, Cleveland, Ohio.

Hyde, Edward Bolton, September, 1911.
Superintendent, Commercial Department, New Amsterdam Gas Company, 130 East 15th Street, New York, New York.

Ikena, Frederick J., September, 1912.
Superintendent of Works, Municipal Gas Company, 1131 Broadway, Albany, New York.

Ives, Herbert E., March, 1913.
Physicist, The United Gas Improvement Company, 3101 Passyunk Avenue, Philadelphia, Pennsylvania.

Jack, Wallace A., March, 1914.
Assistant Construction Engineer, Brooklyn Union Gas Company, 176 Remsen Street, Brooklyn, New York.

Jackson, Alfred H. R., March, 1915.
General Superintendent, Oskaloosa Light & Fuel Company, 202 High Avenue, West, Oskaloosa, Iowa.

Jackson, Dugald C., March, 1914.
Senior Member of Firm of D. C. & Wm. B. Jackson, 248 Boylston Street, Boston, Massachusetts.

Jackson, Thomas H., March, 1910.
General Agent, Philadelphia Gas Works, The United Gas Improvement Company, Broad and Arch Streets, Philadelphia, Pennsylvania.

Jackson, William B., October, 1906.
Consulting Engineer, 111 West Monroe Street, Chicago, Illinois.

Jacobson, Ernest, September, 1910.
Care of David G. Fisher & Company, 202 Bechtel Building, Davenport, Iowa.

James, F. M., October, 1906.
General Accountant, Western United Gas & Electric Company, Aurora, Illinois.

James, Robert C., September, 1907.
General Auditor, The United Gas Improvement Company, 1401 Arch Street, Philadelphia, Pennsylvania.

Jardine, David William, September, 1913.
Assistant Manager, Burlington Light & Power Company, Burlington, Vermont.

Jayne, Ralph A., March, 1913.
Superintendent of Distribution, Detroit City Gas Company, Gas Office Building, Detroit, Michigan.

JELLIFFE, C. N., October, 1906.
Second Vice-President, American Light & Traction Company, 40 Wall Street, New York, New York.

JENNINGS, ROBT. J., October, 1906.
Superintendent, Pelham Works, Westchester Lighting Company, 1st Avenue and 1st Street, Mt. Vernon, New York.

JOCHUM, HENRY LUX, March, 1914.
Field Engineer in Charge, Astoria Construction, Astoria Light, Heat & Power Company, Astoria, Long Island, New York.

JOHNSON, ADOLPH C., September, 1913.
Assistant Superintendent, Consolidated Gas Company, 112 West 42d Street, New York, New York.

JOHNSON, GUY MAXWELL, September, 1912.
Engineer, Nashville Gas & Heating Company, 611 Church Street, Nashville, Tennessee.

JOHNSON, HERBERT GILMORE, October, 1906.
Superintendent of Manufacture, Utica Gas & Electric Company, 222 Genesee Street, Utica, New York.

JOHNSON, OLE SEAHOLM, September, 1913.
Main Foreman, St. Paul Gas Light & Coke Company, 6th and Jackson Streets, St. Paul, Minnesota.

JOHNSTON, MERVYN E., October, 1906.
Assistant Secretary and Assistant Treasurer, Ogden Gas Company, The Linde Air Products Company, 30 East 42d Street, New York, New York.

JONES, ARTHUR OWEN, September, 1912.
Engineer, 4 Gertrude Street, Chelsea, London, S. W., England.

JONES, EDWARD C., October, 1906. (P)
Chief Engineer, Gas Department, Pacific Gas & Electric Company, 702 Grant Building, 7th and Market Streets, San Francisco, California.

JONES, EDWARD STRATTON, September, 1914. (P)
Superintendent Gas Works, Pacific Gas & Electric Company, Sacramento, California.

JONES, EDWIN DUBOSE, March, 1913.
General Foreman, Assistant to Superintendent, Brooklyn Union Gas Company, 176 Remsen Street, Brooklyn, New York.

JONES, EDWIN PEIRCE, September, 1912.
Superintendent, with The United Gas Improvement Company, 1943 South Cecil Street, Philadelphia, Pennsylvania.

JONES, HENRY HARRISON, September, 1912.
Vice-President and Manager, San Diego Consolidated Gas & Electric Company, San Diego, California.

JONES, JACOB B., March, 1915. (P)
Superintendent, Bridgeton Gas Light Company, 26 Water Street, Bridgeton, New Jersey.

JONES, THOMAS CLIVE, October, 1906.
President, Delaware Gas Company, 68 North Sandusky Street, Delaware, Ohio.

JONES, THOMAS J., March, 1907.
With The Columbus Gas & Fuel Company, 135 North Front Street, Columbus, Ohio.

JOURDAN, EDWARD R., October, 1906.
340 Clinton Avenue, Brooklyn, New York.

JOURDAN, JAMES H., October, 1906.
President and Chief Engineer, Brooklyn Union Gas Company, 176 Remsen Street, Brooklyn, New York.

KALTWASSER, CHARLES M., March, 1913.
General Manager, Harrisburg Light & Power Company, Harrisburg, Pennsylvania.

KANE, JOSEPH P., March, 1907.
Superintendent, Westchester Lighting Company, 130 North Main Street, Port Chester, New York.

KEAL, GEORGE I., September, 1911.
Superintendent of Construction, Detroit City Gas Company, Gas Office Building, Detroit, Michigan.

KEEGAN, CHAS. F., September, 1908.
Superintendent, 21st Street Station, Consolidated Gas Company of New York, 501 East 21st Street, New York, New York.

KEENE, ALFRED M., October, 1906.
Comptroller, Westchester Lighting Company, 1st Avenue and 1st Street, Mount Vernon, New York.

KEILLOR, JOHN, March, 1907.
Dominion Tar & Ammonia Company, Ltd., 220 Lister Building, Hamilton, Ontario, Canada.

KELLER, C. M., October, 1906.
President, Columbus Gas Light Company, 312 Washington Street, Columbus, Indiana.

Kelley, William D., September, 1912. (P)
General Superintendent of Meters, Consolidated Gas Company, 130 East 15th Street, New York, New York.

Kellogg, Leonard L., October, 1906.
President, Sioux City Gas & Electric Company, 509 Pierce Street, Sioux City, Iowa.

Kellogg, Raymond C., March, 1909.
Assistant to Superintendent of Street Department, Brooklyn Union Gas Company, 176 Remsen Street, Brooklyn, New York.

Kellogg, R. M., October, 1906.
Assistant Engineer, Westchester Lighting Company, Mount Vernon, New York.

Kelsey, Charles B., September, 1912.
President, American Public Utilities Company, Michigan Trust Building, Grand Rapids, Michigan.

Kendall, Albert Whittemore, March, 1910.
Assistant Manager, Rockford Gas Light & Coke Company, 201 Mulberry Street, Rockford, Illinois.

Kennedy, James S., October, 1906.
Superintendent, Standard Gas Light Company, foot of East 115th Street, New York, New York.

Kennedy, John Pendleton, September, 1907.
General Superintendent, Cambridge Gas Light Company, 354 Third Street, East Cambridge, Massachusetts.

Kennedy, Thomas P., March, 1911.
Assistant Superintendent, Street Department, Brooklyn Union Gas Company, 176 Remsen Street, Brooklyn, New York.

Keppelman, John H., October, 1906.
President and Superintendent, Consumers Gas Company, 20 North Fifth Street, Reading, Pennsylvania.

Keppelmann, D. Ellwood, October, 1906. (P)
General Superintendent of Gas Distribution, Pacific Gas & Electric Company, 445 Sutter Street, San Francisco, California.

Kersting, Albert F., October, 1906.
Engineer, Mobile Gas Company, Box 234, Mobile, Alabama.

King, Arthur Gordon, September, 1909.
Department of Utilization, Consolidated Gas Company, 130 East 15th Street, New York, New York.

Kircher, Harry B., March, 1907.
514 Church Street, Belleville, Illinois.

Klein, August Clarence, September, 1912.
Engineer, The United Gas Improvement Company, 1401 Arch Street, Philadelphia, Pennsylvania.

Klumpp, John Bartleman, October, 1906.
Inspecting Engineer, The United Gas Improvement Company, Broad and Arch Streets, Philadelphia, Pennsylvania.

Knapp, Amos M., October, 1906.
Foreman of Meter Shop, Westchester Lighting Company, 335 Warburton Avenue, Yonkers, New York.

Knapp, Isaac N., October, 1906.
116 Ardmore Avenue, Ardmore, Pennsylvania.

Knapp, William Jared, March, 1910.
Assistant Superintendent, Division Street Station, Peoples Gas Light & Coke Company, 122 South Michigan Avenue, Chicago, Illinois.

Knight, J. J., October, 1906.
Vice-President, Kalamazoo Gas Company, 123 West Street, Kalamazoo, Michigan.

Knowles, William P., October, 1906.
Superintendent, Richmond City Gas Works, 2606 Grove Avenue, Richmond, Virginia.

Kohler, Albert J., September, 1913.
Superintendent, Light and Power Department, Lynchburg Traction & Light Company, 523 Main Street, Lynchburg, Virginia.

Koiner, C. W., October, 1906.
General Manager and Engineer, Municipal Lighting Plant, Pasadena, California.

Kowalke, Otto L., September, 1909.
Associate Professor Chemical Engineering, Engineering Building, University of Wisconsin, Madison, Wisconsin.

Kraft, R. P., October, 1906.
Assistant Engineer, Milwaukee Gas Light Company, 182 Wisconsin Street, Milwaukee, Wisconsin.

Krumrey, Robert Garfield, September, 1913.
General Superintendent, Beloit Water, Gas & Electric Company, 429 East Grand Avenue, Beloit, Wisconsin.

Kubo, Shosuke, September, 1911.
Managing Director of Kobe Gas Company, Ltd., Kobe, Japan.

Kunze, Walter William, March, 1914.
Engineer's Assistant, Brooklyn Union Gas Company, 556 Kent Avenue, Brooklyn, New York.

Kuster, John D., September, 1912. (P)
Manager San Jose District, Pacific Gas & Electric Company, 2nd and Antonio Streets, San Jose, California.

Lambert, Edw. L., September, 1909.
76 Endicott Arcade, St. Paul, Minnesota.

Lamson, William O., Jr., March, 1907.
Manager, Chester County Gas Company, 33 West Gay Street, West Chester, Pennsylvania.

Lane, Frederick K., October, 1906.
Manager and Treasurer, Seattle Lighting Company, Seattle, Washington.

Lane, Jas. M., September, 1909.
Superintendent of Works, Public Service Gas Company, Paterson, New Jersey.

Lane, William P., March, 1908.
Superintendent, Point Breeze Works, United Gas Improvement Company, Passyunk Avenue and Schuylkill River, Philadelphia, Pennsylvania.

Lange, George, March, 1915.
Acting Auditor, New Amsterdam Gas Company, 130 East 15th Street, New York, New York.

Laraway, B. R., September, 1908.
Treasurer and General Manager, Jackson Gas Company, Jackson, Michigan.

Lathrop, Alanson P., October, 1906.
President, American Light & Traction Company, 40 Wall Street, New York, New York.

Lavelle, William J., March, 1913.
Manager Coke Sales Department, New England Coal & Coke Company, 111 Devonshire Street, Boston, Massachusetts.

Lawlor, Jas. W., September, 1908.
Superintendent North Station, Peoples Gas Light & Coke Company, 1122 Crosby Street, Chicago, Illinois.

Lawlor, R. H., October, 1906.
Manager, Indiana Gas Light Company, 74 E. Maple Street, Noblesville, Indiana.

Lawrence, James, March, 1915.
Auditor, American Light & Traction Company, 40 Wall Street, New York, New York.

LAWRENCE, W. F., October, 1906.
Superintendent of Manufacture, Astoria Light, Heat & Power Company, Astoria, Long Island, New York.

LEA, HENRY I., October, 1906.
Consulting Gas Engineer, Peoples Gas Building, Chicago, Illinois.

LEACH, F. A., JR., September, 1912. (P)
Oakland District Manager, Pacific Gas & Electric Company, Post Office Box 426, Oakland, California.

LEARNED, CHARLES A., October, 1906.
General Manager, Meriden Gas Light Company, 33 Colony Street, Meriden, Connecticut.

LEARNED, WALDO A., October, 1906.
General Superintendent, Newton and Watertown Gas Light Company, 308 Washington Street, Newton, Massachusetts.

LEASK, JOHN POLLOCK, September, 1915.
Superintendent's Assistant, Brooklyn Union Gas Company, Nevins and DeGraw Streets, Brooklyn, New York.

LELAND, EDW. D., September, 1909.
Superintendent of Compressing Stations, Philadelphia Company, 435 Sixth Avenue, Pittsburgh, Pennsylvania.

LEONARD, CHARLES F., October, 1906.
Chief Gas Engineer, Public Service Commission, Second District, Albany, New York.

LETANG, B. E., October, 1906.
Proprietor, Jackson Gas Light Company, Jackson, California.

LEWIS, RAYMOND CHAPIN, March, 1911.
704 Garden Street, Hoboken, New Jersey.

LEWIS, WILLIAM MORGAN, October, 1906.
District Manager, Consumers' Power Company, Muskegon, Michigan.

LIGHT, EDWARD H., October, 1906.
Superintendent of Distribution, Dayton Gas Light & Coke Company, 203 East First Street, Dayton, Ohio.

LIGHT, GEORGE, October, 1906.
Superintendent, Dayton Gas Light & Coke Company, 203 East First Street, Dayton, Ohio.

LILLIE, LEWIS, October, 1906.
Third Vice-President, The United Gas Improvement Company, Broad and Arch Streets, Philadelphia, Pennsylvania.

LINDSAY, ROBERT, October, 1906.
Superintendent Gas Department, New Bedford Gas & Edison Light Company, 214 South Water Street, New Bedford, Massachusetts.

Linton, Samuel E., Jr., October, 1906.
General Manager, Nashville Gas Heating Company, 611 Church Street, Nashville, Tennessee.

Little, Arthur Dehon, March, 1908.
President, Arthur D. Little, Inc., 93 Broad Street, Boston, Massachusetts.

Little, A. S. B., September, 1914.
Gas Engineer to State Commission, State Public Utilities Commission, Odd Fellows Building, Springfield, Illinois.

Livingston, H., March, 1909.
Assistant Superintendent Point Breeze Gas Works, The United Gas Improvement Company, Passyunk Avenue and Schuylkill River, Philadelphia, Pennsylvania.

Livingston, Robert E., September, 1911.
Advertising Manager, Consolidated Gas Company, 1 Madison Avenue, New York, New York.

Lloyd, Alfred G., October, 1906.
Vice-President, Adrian (Mich.) Gas Company, 860 Greenwood Avenue, Detroit, Michigan.

Lloyd, Ernest F., October, 1906.
President, Delphos Gas Company, 860 Greenwood Avenue, Detroit, Michigan.

Long, David Samuel, March, 1913.
Meter Department, Gas Company, 18 West Beaver Street, Jacksonville, Florida.

Love, Edward Gurley, March, 1913.
Chief Chemist, Consolidated Gas Company, 130 East 15th Street, New York, New York.

Low, D. W., October, 1906.
Superintendent, Alliance Gas & Electric Company, Alliance, Ohio.

Lucas, Thomas J., September, 1911.
Consulting Engineer, Assistant to W. A. Baehr, 2009 Peoples Gas Building, Chicago, Illinois.

Lucena, Joseph, October, 1906.
Superintendent of Distribution, Omaha Gas Company, 1202 Howard Street, Omaha, Nebraska.

Lucke, Charles Edward, September, 1913.
Professor, Department of Mechanical Engineering, Columbia University, Morningside Heights, New York, New York.

Luckenbach, Charles A., September, 1911.
Manager of Construction, Los Angeles Gas & Electric Corporation, 645 South Hill Street, Los Angeles, California.

Luick, Adolph James, September, 1913.
Assistant Consulting Engineer with W. A. Baehr, 2009 Peoples Gas Building, Chicago, Illinois.

Lundblad, Oscar J. A., March, 1911.
Superintendent, Nassau & Suffolk Lighting Company, Washington Avenue, Hempstead, New York.

Lundgaard, I., March, 1913.
Industrial Engineer, Rochester Railway & Light Company, 34 Clinton Avenue, North, Rochester, New York.

Luqueer, Robert Orr, October, 1906.
Secretary, Humphreys & Miller, Inc., 165 Broadway, New York, New York.

Luther, F. E., October, 1906.
Superinendent, Peoples Gas Light & Coke Company, Michigan Avenue and Adams Street, Chicago, Illinois.

Luther, William J., October, 1906.
Superintendent, Attleboro Gas Light Company, 19 Dunham Street, Attleboro, Massachusetts.

Lydecker, Fredk. Ackerman, March, 1913.
Assistant Superintendent of Distribution, Public Service Gas Company, Spring and Water Streets, Morristown, New Jersey.

Lynn, James T., October, 1906.
President, National Gas, Electric Light & Power Company, Ford Building, Detroit, Michigan.

Lyon, Chas. Lumsden, October, 1906.
Superintendent, St. Augustine Gas & Electric Light Company, St. Augustine, Florida.

Lyons, B. F., October, 1906. (P)
Vice-President and General Manager, Beloit Water, Gas & Electric Company, 429 East Grand Avenue, Beloit, Wisconsin.

McCallum, J. N., October, 1906.
Vice-President, Lenawee County Gas & Electric Company, Adrian, Michigan, 39 South La Salle Street, Chicago, Illinois.

McCarter, Thos. N., September, 1907.
President, Public Service Gas Company, Broad and Bank Streets, Newark, New Jersey.

McClary, N. A., October, 1906.
President, Northwestern Gas Light Company, 108 La Salle Street, Chicago, Illinois.

McClellan, William, September, 1913.
Consulting Gas Engineer, 141 Broadway, New York, New York.

McClellon, J. M., March, 1911.
Superintendent, New England Gas & Coke Company, Everett, Massachusetts.

McCloy, Walter L., September, 1909.
General Superintendent, Philadelphia Company, 435 Sixth Avenue, Pittsburgh, Pennsylvania.

McCorkindale, William J., October, 1906.
General Manager, Wilmington Gas Company, Wilmington, Delaware.

McCrea, Thomas P., March, 1913.
Assistant Secretary, Los Angeles Gas & Electric Corporation, 645 South Hill Street, Los Angeles, California.

McDonald, Donald, October, 1906.
Vice-President and General Manager, Louisville Gas & Electric Company, 311 West Chestnut Street, Louisville, Kentucky.

McDonald, Donald, October, 1906.
With D. McDonald & Company, 991 Broadway, Albany, New York.

McDonald, William, October, 1906.
With D. McDonald & Company, 991 Broadway, Albany, New York.

McDonnell, Charles, September, 1914.
Superintendent Gas Works, Quincy Gas, Electric & Heat Company, 422 Maine Street, Quincy, Illinois.

McDowell, J. C., March, 1907.
General Manager, Kansas Natural Gas Company, Farmers' Bank Building, Pittsburgh, Pennsylvania.

McGowan, Henry Eddy, March, 1911.
General Manager, The Flatbush Gas Company, 176 Remsen Street, Brooklyn, New York.

McGraw, Isaac, March, 1914.
Superintendent, New York Mutual Gas Light Company, 825 East 11th Street, New York, New York.

McGregor, William, October, 1906.
Manager, The Pawtucket Gas Company, 231 Main Street, Pawtucket, Rhode Island.

McGurty, William J., March, 1912.
Assistant Superintendent, Central Union Gas Company, 905 East 138th Street, New York, New York.

McIlhenny, James S., October, 1906.
Engineer, Washington Gas Light Company, 413 10th Street, N. W., Washington, District of Columbia.

McIlhenny, John, October, 1906.
Consulting Engineer, Washington (D. C.) Gas Light Company, 1339 Cherry Street, Philadelphia, Pennsylvania.

McIlhenny, John D., October, 1906.
Managing Director, Portsmouth (Va.) Gas Company, 1339 Cherry Street, Philadelphia, Pennsylvania.

McIntyre, Andrew, September, 1908.
Superintendent, Public Service Company of Northern Illinois, University and Maple Avenues, Evanston, Illinois.

McKay, William E., October, 1906.
Vice-President and General Manager, New England Gas & Coke Company, 111 Devonshire Street, Boston, Massachusetts.

McKee, G. W., October, 1906.
President and Manager, Eclipse Fuel Engineering Company, 100 Forbes Street, Rockford, Illinois.

McKenzie, W. H., October, 1906.
General Manager, Wyandotte County Gas Company, 6th Street and Minnesota Avenue, Kansas City, Kansas.

McLean, George, October, 1906.
President and Manager, The Key City Gas Company, 669 Main Street, Dubuque, Iowa.

McLean, H. B., March, 1908.
General Superintendent, Gas Appliance Department, Consolidated Gas Company, 130 East 15th Street, New York, New York.

McMillin, Emerson, October, 1906.
President, Grand Rapids Gas Light Company, 40 Wall Street, New York, New York.

McMillin, Marion, March, 1909.
Assistant Secretary, American Light & Traction Company, 40 Wall Street, New York, New York.

McQueston, William Morton, March, 1914.
Superintendent Gas Works, Lawrence Gas Company, 34 Marston Street, Lawrence, Massachusetts.

MacArthur, Donald, September, 1913.
Superintendent of Manufacture, Laclede Gas Light Company, Laclede Gas Building, St. Louis, Missouri.

Macbeth, A. B., October, 1906. (P)
Vice-President and General Manager, Southern California Gas Company, Garland Building, Los Angeles, California.

Macbeth, George T., October, 1906.
Engineer, Gas Department, Westchester Lighting Company, First Avenue and First Street, Mount Vernon, New York.

Macdonald, George, October, 1906.
President and General Manager, Nassau and Suffolk Lighting Company of Freeport, New York, 149 Broadway, New York, New York.

MacIntosh, Walter L., March, 1909.
Chief Draftsman, Consolidated Gas Company of New York, 130 East 15th Street, New York, New York.

Mackie, G. W., September, 1913.
Assistant Superintendent, Milwaukee Coke & Gas Company, Colby-Abbott Building, Milwaukee, Wisconsin.

Macklin, A. Fred, September, 1911.
Engineer's Assistant, Manufacturing Department, Consolidated Gas Company, 130 East 15th Street, New York, New York.

MacLeod, Daniel Tate, March, 1914.
Engineer, Otto Coking Company, 6 Church Street, New York, New York.

MacSweeney, Joseph P., March, 1911.
Assistant Commercial Agent, Rochester Railway & Light Company, 34 Clinton Avenue, North, Rochester, New York.

Macy, Carlton, October, 1906.
President, Queens Borough Gas & Electric Company, 345 Central Avenue, Far Rockaway, New York.

Mainland, Sinclair, October, 1906.
Treasurer, Continental Public Utilities Company, Oshkosh, Wisconsin.

Mainland, William, October, 1906.
President, Continental Public Utilities Company, Oshkosh, Wisconsin.

Malone, M. E., October, 1906.
Manager Coke Department, Denver Gas & Electric Company, 900 15th Street, Denver, Colorado.

Maloney, Andrew P., September, 1907.
Official of Gas Companies, Lakewood (N. J.) Gas Company, 2116 Venango Street, Philadelphia, Pennsylvania.

Maloney, Martin 2d, March, 1913.
Assistant to Superintendent, City Gas Light Company, 927 Central Avenue, Ocean City, New Jersey.

Manly, Fred G., September, 1914.
Superintendent, Peoples Gas Light & Coke Company, 2250 South Racine Avenue, Chicago, Illinois.

Mann, Howard E., October, 1906.
Engineer, Montreal Light, Heat & Power Company, Montreal, Canada.

Mansfield, Joseph Hugh, March, 1914.
Superintendent, Department of Mains and Services, Consolidated Gas Company of New York, 300 West 66th Street, New York, New York.

Manson, D. Edgar, September, 1914.
Vice-President, Charles H. Tenney & Company, 201 Devonshire Street, Boston, Massachusetts.

Markley, Joseph C., October, 1906.
Chief Engineer, Metropolitan Gas & Electric Company, 111 West Monroe Street, Chicago, Illinois.

Marks, R. J., October, 1906.
Superintendent, City Gas Company, Norfolk, Virginia.

Marrow, George Peek, September, 1910.
Engineer, Gas Engineer's Department, Consolidated Gas, Electric Light & Power Company, Lexington and Liberty Streets, Baltimore, Maryland.

Marshall, F. L., October, 1906.
Manager, Gas Light Company of Augusta, 809 Broad Street, Augusta, Georgia.

Marshall, William H., October, 1906.
Assistant to Third Vice-President, The United Gas Improvement Company, 1401 Arch Street, Philadelphia, Pennsylvania.

Martin, Edmund H., September, 1908.
Commercial Agent, Des Moines Gas Company, 412 West 7th Street, Des Moines, Iowa.

Martin, Eugene S., September, 1909.
Superintendent, Westchester Lighting Company, Mamaroneck Avenue, White Plains, New York.

Martin, John, October, 1906. (P)
Room 411, 332 Pine Street, San Francisco, California.

Martin, John Gordon, September, 1912.
Manager, Gas & Electric Light Company, 19 East Washington Street, Greencastle, Indiana.

Martin, William Paul, March, 1908.
Vice-President, Peoples Gas Light & Coke Company, 122 South Michigan Avenue, Chicago, Illinois.

Mason, John T., October, 1906.
Superintendent Third Ward Works, Milwaukee Gas Light Company, 129 25th Street, Milwaukee, Wisconsin.

Mather, John L., September, 1908.
General Manager, Counties Gas & Elecric Company, Ardmore, Pennsylvania.

Mathews, Eugene Hamilton, September, 1908.
Superintendent, Citizens' Works, Brooklyn Union Gas Company, 5th and Hoyt Streets, Brooklyn, New York.

Matlack, William H., Jr., March, 1914.
Superintendent, Henrico County Gas Company, 900 North Avenue, Richmond, Virginia.

Maxon, J. H., October, 1906. (P)
General Manager, Central Indiana Gas Company, Muncie, Indiana.

Mayer, Joseph, September, 1914.
President, The Coast Gas Company, Belmar, New Jersey.

Mayers, J. Alex., October, 1906.
Gas Engineer; President, Public Service Construction Company, 30 Broad Street, New York, New York.

Mead, Giles W., September, 1908.
President, Indiana Natural Gas & Oil Company, The Linde Air Products Company, 42d Street Building, New York, New York.

Melick, Thos. L., September, 1907.
Engineer, Central Division, Public Service Gas Company, 249 East 4th Street, Plainfield, New Jersey.

Merchant, O. A., Jr., March, 1907.
Manager, Bangor Gas Light Company, 18 Central Street, Bangor, Maine.

Merritt, Albert H., October, 1906.
General Manager, Niagara Falls Gas & Electric Light Company, 306 Niagara Street, Niagara Falls, New York.

Merritt, W. H., October, 1906.
General Manager, Fremont Gas, Electric Light & Power Company, Fremont, Nebraska.

Middleton, Robert L., October, 1906.
1530 30th Street, N. W., Washington, District of Columbia.

Millard, Frederick Chas., September, 1907.
Consulting Gas Engineer, 425 Merchants Trust Building, Los Angeles, California.

Miller, Alten S., October, 1906.
Vice-President, Humphreys & Miller, Inc., 165 Broadway, New York, New York.

Miller, Carroll, October, 1906.
General Manager and Engineer, Western United Gas & Electric Company, Aurora, Illinois.

Miller, C. O. G., October, 1906. (P)
President, Pacific Lighting Company, 519 California Street, San Francisco, California.

Miller, Daniel, March, 1915. (P)
Chemist, The Barber Asphalt Company, Maurer, New Jersey; 35 Bryant Terrace, Rahway, New Jersey.

Miller, H. C., September, 1913.
Secretary and Treasurer, Northern Indiana Gas & Electric Company, 571 Hohman Street, Hammond, Indiana.

Miller, Robt. C., September, 1909.
Assistant Superintendent, Coke Department, Consolidated Gas Company of New York, 130 East 15th Street, New York, New York.

Miller, Robert S., October, 1906. (P)
Manager, Jackson County Light, Heat & Power Company, 210 West Maple Avenue, Independence, Missouri.

Miller, Thomas David, October, 1906. (P)
Special Representative for E. M. Mancourt, Western Manager, The Consolidation Coal Company, 910 Fisher Building, Chicago, Illinois.

Miller, V. A., September, 1907.
Superintendent and New Business Manager, Canandaigua Gas Light Company, 66 South Main Street, Canandaigua, New York.

Miller, William A., October, 1906.
Chief Engineer, Stacey Bros. Construction Company, 2315 Krouse Avenue, Cincinnati, Ohio.

Milne, David S., October, 1906.
Division Manager, Central Indiana Gas Company, Marion, Indiana.

Mills, Samuel Archibald, March, 1911.
Assistant Superintendent, Williamsburg Works, Brooklyn Union Gas Company, Foot of North 12th Street, Brooklyn, New York.

Milton, Marshall M., September, 1912.
Manager, Roanoke Gas Light Company, Roanoke, Virginia.

Mitchell, Curtis S., September, 1914.
Controller, Philadelphia Company, 435 Sixth Avenue, Pittsburgh, Pennsylvania.

Mitchell, H. J., September, 1914.
District Manager, Western United Gas & Electric Company, 208 North Ottawa Street, Joliet, Illinois.

Mockett, W. E., October, 1906.
Chief Engineer, Gas Deparment, Havana Electric Railway, Light & Power Company, Monte No. 1, Havana, Cuba.

Montgomery, John E., September, 1914.
Superintendent, Gas Department, Birmingham Railway, Light & Power Company, 2100 First Avenue, Birmingham, Alabama.

Moore, Edwin A., March, 1908.
President, American Coke & Gas Construction Company, Camden, New Jersey; 2216 North 52d Street, Philadelphia, Pennsylvania.

Moore, H. M., October, 1906.
Manager, The Crookston Gas Company, 212 North Broadway, Crookston, Minnesota.

Moorhouse, Louis B., September, 1908.
Care of H. L. Doherty & Company, 60 Wall Street, New York, New York.

Morehead, John M., October, 1906.
Consulting Engineer, Peoples Gas Light & Coke Company, 122 South Michigan Avenue, Chicago, Illinois.

Morgan, John Eyre, October, 1906.
Superintendent, Gas Works, Pawtucket Gas Company, 91 Summit Street, Pawtucket, Rhode Island.

Morrell, Edward E., October, 1906.
Treasurer, National Gas & Water Company, 184 La Salle Street, Chicago, Illinois.

Morris, Henry Charles, September, 1912.
General Manager, Dallas Gas Company, Dallas, Texas.

Morris, Robert C., Jr., October, 1906.
200 South High Street, Bethlehem, Pennsylvania.

Morris, W. Cullen, October, 1906. (P)
Engineer of Construction, Consolidated Gas Company of New York, 130 East 15th Street, New York, New York.

Morris, William Giles, March, 1911.
Chief Clerk, Consolidated Gas Company, 130 East 15th Street, New York, New York.

Morris, William T., October, 1906.
President and Treasurer, United States Gas & Electric Company, Penn Yan, New York.

Morrison, Henry K., October, 1906.
General Manager, Lynn Gas & Electric Company, 90 Exchange St., Lynn, Massachusetts.

Morton, Albert B., September, 1907.
Superintendent, Rome Gas, Electric Light & Power Company, 139 North James Street, Rome, New York.

Morton, F. N., October, 1906.
Engineer, with The United Gas Improvement Company, Broad and Arch Streets, Philadelphia, Pennsylvania.

Moses, Frank D., October, 1906.
Engineer, Gas Engineering Company, 7 North Stockton Street, Trenton, New Jersey.

Moulton, Walter Ross, September, 1915.
Illuminating Engineer, Consolidated Gas, Electric Light & Power Company, 325 North Charles Street, Baltimore, Maryland.

Mueller, M. E., September, 1909.
Assistant Superintendent of Manufacture, Astoria Light, Heat & Power Company, Astoria, Long Island, New York.

Mulholland, S. E., October, 1906.
Assistant General Manager, Indiana Lighting Company, 1117 West Jefferson Street, Fort Wayne, Indian...

Munson, Ralph Ira, March, 1912.
Secretary, Bridgeport Gas Light Company, 799 Main Street, Bridgeport, Connecticut.

Murdock, James W., October, 1906.
General Superintendent, Underlying Companies, Associated Gas & Electric Company, Ithaca, New York.

Murdock, S. T., October, 1906.
Managing Director, Indiana Lighting Company, 1414 Merchants Bank Building, Indianapolis, Indiana.

Murphy, Edward J., September, 1913.
Assistant Chemist, Brooklyn Union Gas Company, 5th and Hoyt Streets, Brooklyn, New York.

Murray, John J., March, 1911.
Superintendent, Philadelphia Company, 435 6th Avenue, Pittsburgh, Pennsylvania.

Myers, Edward Brittain, October, 1906.
Appliance Engineer, The United Gas Improvement Company, 1401 Arch Street, Philadelphia, Pennsylvania.

Myers, Joseph B., October, 1906.
Commercial Agent, The United Gas Improvement Company, 134 North 13th Street, Philadelphia, Pennsylvania.

Naphtaly, Samuel L., October, 1906.
President, Nevada Narrow Gauge Railroad Company, 305 Hobart Building, San Francisco, California.

Nelson, John F., March, 1909.
134 East 43d Street, New York, New York.

Nettles, Rosco, September, 1911.
Secretary, Tampa Gas Company, Tampa, Florida.

Nettleton, Charles H., October, 1906. (P)
President, Derby Gas Company and New Haven Gas Light Company, 22 Elizabeth Street, Derby, Connecticut.

Nevanas, Harold Honey, March, 1914.
General Coal Gas Foreman, The United Gas Improvement Company, 1401 Arch Street, Philadelphia, Pennsylvania.

Newberry, F. E., October, 1906.
584 South Chicago Avenue, Kankakee, Illinois.

Nichols, William B., September, 1912.
Assistant General Manager, Citizens Gas Light Company, 11 Granite Street, Quincy, Massachusetts.

Nickerson, Franklin Hezekiah, March, 1911.
Chief Statistician, Consolidated Gas Company, 130 East 15th Street, New York, New York.

Norcross, J. Arnold, October, 1906.
Secretary and Treasurer, New Haven Gas Light Company, 80 Crown Street, New Haven, Connecticut.

Norris, Rollin, October, 1906.
General Superintendent, The United Gas Improvement Company, Broad and Arch Streets, Philadelphia, Pennsylvania.

North, Edwin, March, 1910.
Purchasing Agent, Consolidated Gas Company of New York, 130 East 15th Street, New York, New York.

Norton, Walter F., October, 1906.
Superintendent, Gas Department, Nashua Light, Heat & Power Company, 70 East Pearl Street, Nashua, New Hampshire.

NORTON, WILLIAM J., September, 1913.
Special Consulting Work Engineer, 111 West Monroe Street, Chicago, Illinois.

NUTE, JOSEPH E., October, 1906. (P)
Manager, Fall River Gas Works Company, 155 North Main Street, Fall River, Massachusetts.

O'CONNELL, JOHN, March, 1913.
General Foreman of Gas Making, Consolidated Gas Company, 501 East 21st Street, New York, New York.

O'DONNELL, CHAS. J., April, 1908.
Assistant to Engineer of Tests, The United Gas Improvement Company, 1401 Arch Street, Philadelphia, Pennsylvania.

ODRICH, ERICH, September, 1914.
Engineer and Manager, Manila Gas Corporation, Manila, Philippine Islands.

OFFUTT, M. **WEBB**, March, 1908.
Engineer, Care of Engineers' Club, 32 West 40th Street, New York, New York.

OKAMOTO, SAKURA, March, 1909.
Chief Engineer and Manager, Nagoya Gas Company, Nagoya, Japan.

OLDS, HOWARD L., October, 1906.
Assistant Vice-President, Middle West Utilities Company, 72 West Adams Street, Chicago, Illinois.

OLMSTED, GEORGE G., October, 1906.
105 South LaSalle Street, Chicago, Illinois.

OLSEN, EDWARD, September, 1914.
Superintendent of Manufacture, Benton Harbour-St. Joseph Gas & Fuel Company, 211 Lake Avenue, Benton Harbour, Michigan.

O'MALLEY, PATRICK, October, 1906.
Engineer, Western United Gas & Electric Company, 95 Prairie Street, Aurora, Illinois.

OSBORN, ARTHUR H., March, 1914.
President, City Gas Light Company, 11th and Haven Avenues, Ocean City, New Jersey.

OSTHOFF, OTTO E., October, 1906.
Vice-President and Chief Engineer, H. M. Byllesby & Company, Insurance Exchange Building, Chicago, Illinois.

OTTEN, CHARLES, JR., March, 1907.
Superintendent, Haverhill Gas Light Company, 28 Washington Square, Haverhill, Massachusetts.

PAIGE, CLIFFORD E., March, 1909.
Manager, Malden & Melrose Gas Light Company, 137 Pleasant Street, Malden, Massachusetts.

PALMER, A. J., March, 1909.
Superintendent of Works, Bridgeport Gas Light Company, Howard Avenue Works, Bridgeport, Connecticut.

PALMER, E. H., October, 1906.
President, Auburn Gas Company, Seneca Falls & Waterloo Gas Light Company, Geneva, New York.

PALMER, HARRY C., October, 1906.
Engineer, Buffalo Gas Company, 186 Main Street, Buffalo, New York.

PAPST, HILMAR MAXIMILIAN, March, 1911.
General Manager, Portland Gas & Coke Company, 5th and Yamhill Streets, Portland, Oregon.

PARCHER, SAMUEL L., September, 1912.
York Light & Heat Company, 233 Main Street, Biddeford, Maine.

PARK, FREDERICK EDWIN, March, 1914.
Superintendent Anhydrous Ammonia Plant, Union Stock Yards, Morris & Company, Chicago, Illinois.

PARKER, FRANK H., October, 1906.
Manager, Burlington Light & Power Company, 102 South Winooski Avenue, Burlington, Vermont.

PARKER, JOSEPH SMITH, October, 1906.
Superintendent, Frankford District, The United Gas Improvement Company, 4427 Frankford Avenue, Philadelphia, Pennsylvania.

PARKER, RICHARD MARSH, October, 1906.
General Manager, Fort Dodge Gas & Electric Company, 24 South 9th Street, Fort Dodge, Iowa.

PARKHURST, GEORGE W., September, 1914.
Secretary, New York Mutual Gas Light Company, 36 Union Square, New York, New York.

PARSHALL, A., March, 1913.
Consulting Engineer, Appraising Properties of Gas and Electric Companies, New York Athletic Club, Central Park South, New York, New York.

PARTRIDGE, WARREN, September, 1909.
General Manager, Penn Public Service Company, Clearfield, Pennsylvania.

PATT, EVERETT I., March, 1914.
Superintendent, Pawtucket Gas Company, 231 Main Street, Pawtucket, Rhode Island.

PAYNE, A. I., October, 1906.
Consulting Gas Engineer, Post Office Box 571, Calgary, Alberta, Canada.

PEARSON, J. A., October, 1906.
Purchasing Agent, The United Gas Improvement Company, 1401 Arch Street, Philadelphia, Pennsylvania.

PEARSON, W. H., October, 1906.
34 North Sherbourne Street, Toronto, Ontario, Canada.

PECK, HENRY W., March, 1912.
Vice-President and General Manager, Mohawk Gas Company, 511 State Street, Schenectady, New York.

PEEBLES, EDWIN C., March, 1914.
General Manager, Rockland Light & Power Company, 2 North Broadway, Nyack, New York.

PELTON, BERT F., October, 1906.
Superintendent Gas Distribution, St. Paul Gas Light Company, 6th and Jackson Streets, St. Paul, Minnesota.

PENINGTON, DUDLEY W., March, 1912.
Assistant Superintendent, South Division Street Department, Peoples Gas Light & Coke Company, 38 West 64th Street, Chicago, Illinois.

PERKINS, BENJAMIN W., October, 1906.
General Manager, Hartford City Gas Light Company, 565 Main Street, Hartford, Connecticut.

PERKINS, JAY HUGH, October, 1906.
Consulting Electrical Engineer, United Gas & Electric Engineering Corporation, 61 Broadway, New York, New York.

PERRY, JOSEPH A., October, 1906.
Assistant to General Superintendent, The United Gas Improvement Company, 1401 Arch Street, Philadelphia, Pennsylvania.

PETTES, W. H., October, 1906.
General Auditor, Public Service Gas Company, Post Office Box 590, Newark, New Jersey.

Petty, John P., March, 1915.
11th Floor, 790 Broad Street, Newark, New Jersey.

Philbrick, Joseph E., September, 1911.
Care of New England Manufacturing Company, North Woburn, Massachusetts.

Pipkin, Jesse E., September, 1913.
Superintendent, Station B, Laclede Gas Light Company, Laclede Gas Building, St. Louis, Missouri.

Plummer, H. W., October, 1906.
Manager, Asheville Power & Light Company, Asheville, North Carolina.

Polk, Roger W., October, 1906.
Consulting Gas Engineer, 193 Washington Avenue, Providence, Rhode Island.

Pollitt, L. Irving, October, 1906.
Vice-President and General Manager, Southern Gas & Electric Corporation, 213 Courtland Street, Baltimore, Maryland.

Poole, Eugene Warren, September, 1915.
Treasurer and Assistant Secretary, Syracuse Lighting Company, 335 South Warren Street, Syracuse, New York.

Porter, Dugald Gilbert, 1915.
Assistant Manager, Peoples Power Company, Safety Building, Rock Island, Illinois.

Porter, Edward, September, 1913.
Special Accountant, General Auditor's Department, The United Gas Improvement Company, 1401 Arch Street, Philadelphia, Pennsylvania.

Porter, Joseph F., October, 1906.
President, Tri-City Railway & Light Company, Davenport, Iowa.

Potter, Ormsby F., March, 1914.
Assistant to General Auditor, Public Service Gas Company, Broad and Bank Streets, Newark, New Jersey.

Powell, David A., September, 1909.
Engineer's Assistant, Milwaukee Gas Light Company, 182 Wisconsin Street, Milwaukee, Wisconsin.

Pratt, Charles Oland, March, 1914.
Superintendent of Construction, Portland Gas Light Company, 40 West Commercial Street, Portland, Maine.

Pratt, Edward G., October, 1906.
Consulting Gas Engineer and President, Boone (Iowa) Gas Company, 627 Peoples Gas Building, Chicago, Illinois.

PRICHARD, CHAS. R., September, 1909.
Superintendent, Beverly Gas & Electric Company, Beverly, Massachusetts.

PRIEST, GEORGE HEYWOOD, March, 1910.
Gas Engineer, Stone & Webster Engineering Corporation, 147 Milk Street, Boston, Massachusetts; R. F. D., Framingham, Massachusetts.

PRINTZ, CHARLES H., October, 1906.
Vice-President, Gas Machinery Company, 1900 Euclid Avenue, Cleveland, Ohio.

PURCELL, THEO. V., October, 1906.
Peoples Gas Light & Coke Company, 122 South Michigan Avenue, Chicago, Illinois.

PUTNAM, WILLIAM R., October, 1906.
New Business Manager, Utah Power & Light Company, Kearns Building, Salt Lake City, Utah.

QUACKENBUSH, CHARLES H., October, 1906.
Manager, St. Clair County Gas & Electric Company, 414 Missouri Avenue, East St. Louis, Illinois.

QUINN, ANDREW K., October, 1906.
President, Newport Gas Light Company, 181 Thames Street, Newport, Rhode Island.

RAABE, CHARLES, March, 1910.
Assistant to Superintendent, Consolidated Gas Company, 501 East 21st Street, New York, New York.

RAFFERTY, JAMES ALOYSIUS, September, 1910.
Assistant Superintendent, Peoples Gas Light & Coke Company, 1122 Crosby Street, Chicago, Illinois.

RAHN, BRUNO, March, 1914.
Engineering Department, Milwaukee Gas Light Company, 182 Wisconsin Street, Milwaukee, Wisconsin.

RAMSBURG, CHARLES J., October, 1906.
Second Vice-President, H. Koppers Company, First National Bank Building, 511 Wood Street, Pittsburgh, Pennsylvania.

RAMSDELL, GEORGE G., October, 1906. (P)
Secretary and Treasurer, American Gas Institute, 29 West 39th Street, New York, New York.

RANDOLPH, WILLIAM W., October, 1906.
Consulting Engineer, Woolworth Building, 233 Broadway, New York, New York.

Ray, William Daniel, March, 1911.
Manager, General Gas & Electric Company, Easton, Pennsylvania.

Redd, John Barnett, September, 1915. (P)
Sales Department Davis-Bournonville Company, Van Wagenen Avenue, Jersey City, New Jersey.

Reed, James H., Jr., September, 1909.
General Purchasing Agent, Philadelphia Company, 435 Sixth Avenue, Pittsburgh, Pennsylvania.

Reed, Joseph A., March, 1911.
Assistant General Superintendent, Philadelphia Company, 435 Sixth Avenue, Pittsburgh, Pennsylvania.

Rees, Richard, October, 1906.
Superintendent Bookkeeping Department, Peoples Gas Light & Coke Company, Michigan Avenue and Adams Street, Chicago, Illinois.

Reeside, Howard S., March, 1914.
President, Washington Gas Light Company, 413 10th Street, N. W., Washington, D. C.

Reimers, Frederick William, September, 1912.
General Manager, Natalbany Lumber Company, Hammond, Louisiana.

Reinach, Hugo B., March, 1911.
Assistant General Superintendent, Commercial Department, Consolidated Gas Company, 130 East 15th Street, New York, New York.

Reinhard, Solon A., September, 1910.
Assistant Superintendent of Works, Peoples Gas Light & Coke Company, 1129 Dearborn Avenue, Chicago, Illinois.

Reinicker, Charles E., March, 1912.
Assistant Gas Engineer, Bureau of Standards, Washington, District of Columbia.

Reitemeyer, A. F., October, 1906.
Secretary and Treasurer, Perth Amboy Gas Light Company, 196 Smith Street, Perth Amboy, New Jersey.

Rew, Irwin, October, 1906.
Vice-President, DeKalb County (Ill.) Gas Company, and Sterling (Ill.) Gas & Electric Company, 108 South LaSalle Street, Chicago, Illinois.

Rhoades, William R., October, 1906.
General Manager, Northern Central Gas Company, Williamsport, Pennsylvania.

Rice, Henry L., October, 1906.
Consulting Engineer, First National Bank Building, Milwaukee, Wisconsin.

Richards, J. L., September, 1907.
President and General Manager, Boston Consolidated Gas Company, 24 West Street, Boston, Massachusetts.

Richter, Arthur W., October, 1906.
Professor of Engineering, University of Montana, Bozeman, Montana.

Rieha, Edward L., October, 1906. (P)
Secretary, Sumter Gas & Power Company, Sumter, South Carolina; 213 Courtland Street, Baltimore, Maryland.

Riggins, John A., March, 1914.
President, New Jersey Northern Gas Co., Court House Square Building, Camden, New Jersey.

Riley, Henry M., September, 1915.
Assistant Superintendent, Distribution Department, Consolidated Gas, Electric Light & Power Company, 1068 North Front Street, Baltimore, Maryland.

Riselay, William S., October, 1906.
Secretary and Treasurer, Buffalo Gas Company and Peoples Gas Light & Coke Company, 186 Main Street, Buffalo, New York.

Ritter, Charles S., October, 1906.
Secretary and Assistant Treasurer, Detroit City Gas Company, Gas Office Building, Detroit, Michigan.

Rix, Austin J., March, 1915. (P)
Superintendent, Gas Department, Pacific Gas & Electric Company, 365 Mission Street, San Rafael, California.

Roberts, E. C., September, 1907.
Division Agent, Public Service Gas Company, 114 Main Street, Hackensack, New Jersey.

Roberts, F. M., October, 1906.
Manager, Haverhill Gas Light Company, 28 Washington Square, Haverhill, Massachusetts.

Roberts, George J., October, 1906.
First Vice-President, Public Service Gas Company, 759 Broad Street, Newark, New Jersey.

Roberts, Geo. W., March, 1909.
Treasurer, Bridgeport Gas Company, 799 Main Street, Bridgeport, Connecticut.

Robison, Charles D., October, 1906.
Consulting Engineer, Forstall & Robison, 84 William Street, New York, New York.

Rodgers, William Joseph, September, 1913.
Assistant Superintendent of Distribution, Public Service Gas Company, 2d and Cherry Streets, Camden, New Jersey.

Roeser, Charles J., September, 1907.
Engineer, East 5th Street Works, Public Service Gas Company, Paterson, New Jersey.

Rogers, Fred Alfred, September, 1913.
Secretary and General Manager, Watertown Light & Power Company, 137 Arsenal Street, Watertown, New York.

Rogers, John McClelland, September, 1908.
Assistant to Purchasing Agent, Public Service Gas Company, 759 Broad Street, Newark, New Jersey.

Rogers, W. H., October, 1906.
Agent, Passaic Division, Public Service Gas Company, 188 Ellison Street, Paterson, New Jersey.

Roohan, Patrick F., October, 1906.
Superintendent, Adirondack Electric Power Corporation, 491 Broadway, Saratoga Springs, New York.

Roper, George D., October, 1906. (P)
President, Eclipse Gas Stove Company, Vice-President, Boone (Iowa) Gas Company, Rockford, Illinois.

Rosenquest, Eugene H., October, 1906.
President and General Manager, Bronx Gas & Electric Company, Walker and Frisbie Avenues, Westchester, New York.

Rosenthal, Albert, October, 1906.
General Contractor, Claiborne, Johnston & Company, 910 Garrett Building, Baltimore, Maryland.

Rossman, G. M., October, 1906.
Treasurer, Keene Gas & Electric Company, 18 Roxbury Street, Keene, New Hampshire.

Rowland, Charles L., October, 1906.
Consulting Engineer, American Welding Company, Carbondale, Pennsylvania.

Rowland, William L., October, 1906.
Chemical Engineer, Henry Bower Chemical Manufacturing Company, 2815 Gray's Ferry Road, Philadelphia, Pennsylvania.

Royce, Frederick P., October, 1906.
Stone & Webster Management Association, 147 Milk Street, Boston, Massachusetts.

Ruegenberg, John M., March, 1907.
Superintendent, Northern Liberties Gas Company, The United Gas Improvement Company, 3d and Brown Streets, Philadelphia, Pennsylvania.

Runner, R. K., October, 1906.
Secretary and Manager, Gas Company, 709 Kelly Street, Charles City, Iowa.

Rusby, John M., October, 1906.
Engineer of Tests, The United Gas Improvement Company, Broad and Arch Streets, Philadelphia, Pennsylvania.

Russell, Herman, September, 1907.
Superintendent of Gas Manufacturing, Rochester Railway & Light Company, 634 Averill Avenue, Rochester, New York.

Rutledge, Fred J., September, 1909.
Commercial Agent, The United Gas Improvement Company, Broad and Arch Streets, Philadelphia, Pennsylvania.

Sands, Howard T., March, 1913.
General Manager, Malden & Melrose Gas Light Company, 201 Devonshire Street, Boston, Massachusetts.

Sargeant, Frank Washburn, September, 1908.
Superintendent of Distribution, Citizens Gas Company, 31 South Pennsylvania Street, Indianapolis, Indiana.

Sargent, Fred H., October, 1906.
Assistant Agent, Lawrence Gas Company, 370 Essex Street, Lawrence, Massachusetts.

Sawyer, F. H., October, 1906.
General Manager, New Bern Gas Company, New Bern, North Carolina.

Schaaf, August Henry, March, 1914.
Photometric Inspector, Brooklyn Union Gas Company, 130 Atlantic Avenue, Brooklyn, New York.

Schaddelee, Richard, October, 1906.
Vice-President, United Light & Railway Company, 411 Michigan Trust Building, Grand Rapids, Michigan.

Schauer, Frank F., October, 1906.
Assistant Engineer, Kansas City Gas Company, 910 Grand Avenue, Kansas City, Missouri.

Schenck, Rudolph, October, 1906.
Assistant Engineer, Peoples Gas Light & Coke Company, 122 South Michigan Avenue, Chicago, Illinois.

Scherck, Leon H., October, 1906.
Sales Manager, Central Hudson Gas & Electric Company, 50 Market Street, Poughkeepsie, New York.

Schick, Karl August, March, 1911.
Assistant Superintendent, Commercial Department, Rochester Railway & Light Company, 34 Clinton Avenue, North, Rochester, New York.

Schiller, Charles C., October, 1906.
Superintendent of Meters, Peoples Gas Light & Coke Company, 122 South Michigan Avenue, Chicago, Illinois.

Schindler, Morris Daniel, September, 1912.
Manager, Gas Light Company of Augusta, Augusta, Georgia.

Schlesinger, Ferdinand, March, 1914.
President, Milwaukee Coke & Gas Company, 1112 First National Bank Building, Milwaukee, Wisconsin.

Schmidt, Edgar Henry, September, 1914.
Fitting Shop Superintendent, Northern Union Gas Company, 1815 Webster Avenue, New York, New York.

Schmidt, Emil G., October, 1906.
President, Des Moines City Railway Company, Des Moines, Iowa.

Schmidt, F. W., October, 1906.
Division Agent, Public Service Gas Company, 84 Sip Avenue, Jersey City, New Jersey.

Schneider, Philip J., March, 1911.
Treasurer, Central Union Gas Company, 519 Courtlandt Avenue, New York, New York.

Schobel, Frederick A., March, 1911.
Superintendent of Distribution, Municipal Gas Company, 1131 Broadway, Albany, New York.

Schroeder, Albert George, September, 1912.
Purchasing Agent, Grand Rapids Gas Light Company, Ottawa and Pearl Streets, Grand Rapids, Michigan.

Schultz, Walter F. H., March, 1915.
Chief Engineer, Dessauer Vertical Oven Company, Berlin, The United Gas Improvement Company, 1401 Arch Street, Philadelphia, Pennsylvania.

Schutt, Harry S., October, 1906. (P)
General Manager, C. H. Geist Company, 1127 Land Title Building, Philadelphia, Pennsylvania.

Schwabe, Walter P., March, 1911.
General Manager, Northern Connecticut Light & Power Company, 15 Central Street, Thompsonville, Connecticut.

Schwarm, C. A., October, 1906.
General Superintendent, Henry M. Wallace Company, 612 Union Trust Building, Detroit, Michigan.

SCOBELL, E. C., October, 1906.
Assistant Auditor, Rochester Railway & Light Company, 34 Clinton Avenue, North, Rochester, New York.

SCOFIELD, THOMAS, September, 1910.
Illuminating Engineer, Consolidated Gas Company, 130 East 15th Street, New York, New York.

SCOTT, ALEXANDER H., September, 1908.
Engineer, Peoples Gas Light Company, 39 Hanover Street, Manchester, New Hampshire.

SCOTT, JOHN JOSEPH, September, 1912.
Superintendent, Lewiston Gas Light Company, 88 Shawmut Street, Lewiston, Maine.

SCOTT, JOHN M., September, 1908.
Secretary and Treasurer, Kansas City Gas Company, 910 Grand Avenue, Kansas City, Missouri.

SCOTT, ROSSITER STOCKTON, March, 1908.
Assistant Engineer, Consolidated Gas, Electric Light & Power Company, Baltimore, Maryland.

SCRANTON, GEORGE H., October, 1906.
Secretary, Derby Gas Company, 22 Elizabeth Street, Derby, Connecticut.

SCRANTON, WORTHINGTON, October, 1906.
Vice-President, Hyde Park Gas Company, 115 Wyoming Avenue, Scranton, Pennsylvania.

SEAMON, J. FRED, October, 1906.
Engineer of Manufacture and Construction, 165 Hayward Street, Brooklyn, New York.

SEARLE, ROBERT M., October, 1906.
Vice-President, Rochester Railway & Light Company, 34 Clinton Avenue, North, Rochester, New York.

SECORD, WARREN L., October, 1906.
General Superintendent of Meters, Westchester Lighting Company, First Avenue and First Street, Mt. Vernon, New York.

SEDDON, SAMUEL VENABLE, September, 1913.
Superintendent, Metropolitan Works, Brooklyn Union Gas Company, 12th Street and Gowanus Canal, Brooklyn, New York.

SERRILL, WILLIAM J., October, 1906.
Engineer of Distribution, Philadelphia Gas Works, The United Gas Improvement Company, Broad and Arch Streets, Philadelphia, Pennsylvania.

SEYMOUR, FREDK. WARNER, September, 1912.
Superintendent of Manufacture, Grand Rapids Gas Light Company, Grand Rapids, Michigan.

Seymour, William W., October, 1906.
President, Gray's Harbor Gas Company of Aberdeen, Washington, 324 Tacoma Building, Tacoma, Washington.

Shacklette, R., October, 1906.
Secretary and General Manager, Big Rapids Gas Company, Big Rapids, Michigan.

Shaeffer, John Wallace, March, 1911.
Superintendent, The Milwaukee Coke & Gas Company, 187 Greenfield Avenue, Milwaukee, Wisconsin.

Shaffner, Samuel C., March, 1907.
Middle West Utilities Company, 6105 Kimbark Avenue, Chicago, Illinois.

Shattuck, A. F., October, 1906.
Chief Chemist, The Solvay Process Company, Solvay and Jefferson Avenues, West, Detroit, Michigan.

Shattuck, John D., October, 1906.
General Manager, Philadelphia Gas & Electric Company, 6th and Welsh Streets, Chester, Pennsylvania.

Shaul, Clifford Dale, September, 1914.
General Manager, Citizens Gas & Fuel Company, 636 Wabash Avenue, Terre Haute, Indiana.

Shaw, H. S., October, 1906.
Treasurer and Superintendent, Webster Electric Company, Webster, Massachusetts.

Shaw, John Cargill, September, 1913.
Assistant Superintendent, Mechanical Department, Astoria Light, Heat & Power Company, 530 Third Avenue, Astoria, Long Island, New York.

Shepard, Frederick C., October, 1906.
Superintendent, Minneapolis Gas Light Company, 16 Seventh Street, Minneapolis, Minnesota.

Shepard, Richard, September, 1912.
Superintendent of Pavements and General Storekeeper, Consolidated Gas Company, 130 East 15th Street, New York, New York.

Sherwood, E. J., October, 1906.
Manager, Mitchell Power Company, Mitchell, South Dakota.

Sherwood, M. S., September, 1907.
Agent, Gas Department, Public Service Gas Company, 446 Springfield Avenue, Summit, New Jersey.

Shiebler, Marvin, September, 1908.
Gas Engineer, 30 Church Street, New York, New York.

Shields, Henry C., March, 1913.
Vice-President and General Manager, Troy Gas Company, Troy, New York.

Shimomura, Kotaro, September, 1914.
Chief Engineer, Osaka Gas Company, Osaka, Japan.

Silverthorn, James C., March, 1911.
Gas and Electric Light Company, Evansville, Indiana.

Simons, Keating Lewis, September, 1907. (P)
Vice-President and General Manager, El Paso Gas and Electric Company, El Paso, Texas.

Simpson, Colin C., March, 1911.
General Superintendent of Mains and Services, Consolidated Gas Company, 130 East 15th Street, New York, New York.

Simpson, Henry, March, 1911.
Superintendent, Consolidated Gas Company, 112 West 42d Street, New York, New York.

Singer, Sidney Charles, March, 1908.
Superintendent of Distribution, Syracuse Lighting Company, 736 South Beech Street, Syracuse, New York.

Sinsel, Otis A., October, 1906.
Assistant Engineer, Detroit City Gas Company, 57 Webb Avenue, Detroit, Michigan.

Sissingh, Melchior Corstius, March, 1914.
Manager, Municipal Gas Works, Rotterdam, "Gemeente-Gasbedryf," Oost-Zeedyk, Rotterdam.

Slade, Richmond E., October, 1906.
Engineer, Providence Gas Company, Turks Head Building, Providence, Rhode Island.

Slater, Surrey W., March, 1914.
Superintendent's Assistant, Brooklyn Union Gas Company, 176 Remsen Street, Brooklyn, New York.

Sloan, J. C., October, 1906.
Manager, Port Huron Gas Company, Port Huron, Michigan.

Smart, Burton, September, 1915.
Treasurer, Portland Gas Light Company, P. O. Box 668, Portland, Maine.

Smith, A. J., October, 1906.
Superintendent, Concord Light & Power Company, 90 North Main Street, Concord, New Hampshire.

Smith, Charles G., March, 1915.
Superintendent, Consolidated Gas Company, 130 East 15th Street, New York, New York.

Smith, Elmer W., March, 1907.
Manager, Kewanee Light & Power Company, Kewanee, Illinois.

Smith, Geo. P., Jr., September, 1910.
Superintendent, Old Colony Gas Company, Quincy Avenue, East Braintree, Massachusetts.

Smith, H. M., March, 1914.
General Superintendent, Citizens Gas & Electric Company, 714 Bayard Street, Waterloo, Iowa.

Smith, J. Henderson, September, 1913.
Chief Clerk, General Auditor's Department, The United Gas Improvement Company, 1401 Arch Street, Philadelphia, Pennsylvania.

Smith, Louis C., September, 1913.
Manager, Fulton County Gas & Electric Company, 18 East Fulton Street, Gloversville, New York.

Smith, Raymond H., March, 1909.
General Manager, Jackson Light & Traction Company, 720 Arlington Street, Jackson, Mississippi.

Smith, Shaler G., March, 1914.
Engineer, Cedar Valley Power Company, Charles City, Iowa.

Snow, William H., October, 1906.
General Manager, New Bedford Gas & Edison Light Company, 693 Purchase Street, New Bedford, Massachusetts.

Snyder, Albert I., September, 1911.
President, Utilities Engineering Corporation, 1458 Robinson Road, Grand Rapids, Michigan.

Snyder, Charles S., March, 1907.
Superintendent, West Philadelphia District, The United Gas Improvement Company, 4650 Market Street, Philadelphia, Pennsylvania.

Snyder, Harry L., March, 1911.
Secretary and Treasurer, New York & Queens Electric Light & Power Company, 444 Jackson Avenue, Long Island City, New York.

Sombart, W. E., October, 1906.
Secretary and Treasurer, Sombart Gas Company, Boonville, Missouri.

Soult, George H., March, 1911.
Assistant District Superintendent, Public Service Gas Company, 175 Ridgewood Avenue, Ridgewood, New Jersey.

Spangenberg, Brewster H., October, 1906.
Toms River, New Jersey.

SPEAKER, GEORGE S., March, 1912.
Treasurer and General Manager, Lebanon Gas & Fuel Company, 17 North 8th Street, Lebanon, Pennsylvania.

SPEAR, M. H., October, 1906.
Secretary and Manager, New York & Queens Gas Company, 88 Main Street, Flushing, New York.

SPENCER, ELLIOTT L., March, 1912.
Engineer, Central Union Gas Company, 905 East 138th Street, New York, New York.

SPERLING, NATH. JOS., September, 1909.
Superintendent, Mechanical Department, Astoria Light, Heat & Power Company, Astoria, Long Island, New York.

SPITZGLASS, JACOB M., September, 1912. (P)
Mechanical Engineer, Peoples Gas Light & Coke Company, 1701 Peoples Gas Building, Chicago, Illinois.

SPRAGLE, L. D., October, 1906.
General Manager, Berwick Gas Company, 102 Mulberry Street, Berwick, Pennsylvania.

SQUIER, HAROLD NEWTON, September, 1912.
Superintendent, Hyde Park Gas Company, 115 Wyoming Avenue, Scranton, Pennsylvania.

STACEY, FREDERICK A., October, 1906.
President, Chillicothe Gas & Water Company, Chillicothe, Ohio.

STACK, EDWARD M., March, 1910. (P)
General Superintendent, Hyde Park Gas Company, 115 Wyoming Avenue, Scranton, Pennsylvania.

STANIFORD, ARTHUR FOWLER, March, 1908.
Vice-President, Brooklyn Union Gas Company, 176 Remsen Street, Brooklyn, New York.

STANNARD, CLARE N., October, 1906.
Secretary and Commercial Manager, Denver Gas & Electric Company, 900 15th Street, Denver, Colorado.

STARK, ARTHUR WILLIAM, March, 1913.
Engineer's Assistant, Consolidated Gas Company of New York. 130 East 15th Street, New York, New York.

STEALEY, LEE G., March, 1912.
Manager, St. Charles Lighting Company, St. Charles, Missouri.

STEELE, G. W., March, 1909.
Manager, Lehigh-Northampton Light, Heat & Power Company, 123 Bridge Street, Catasauqua, Pennsylvania.

Steinwedell, George, October, 1906.
Commercial Manager, St. Paul Gas Light Company, Sixth and Jackson Streets, St. Paul, Minnesota.

Steinwedell, W. E., October, 1906.
Secretary, Gas Machinery Company, 1900 Euclid Avenue, Cleveland, Ohio.

Stevick, Crist H., October, 1906.
Superintendent, Ravenswood Works, New Amsterdam Gas Company, 58 Woolsey Street, Astoria, Long Island, New York.

Stewart, C. Howard, September, 1915.
Assistant to Secretary and Treasurer, Laclede Gas Light Company, 1017 Olive Street, St. Louis, Missouri.

Stewart, Samuel B., October, 1906.
General Contracting Agent, Philadelphia Company, and Consolidated Gas Company, 435 Sixth Avenue, Pittsburgh, Pennsylvania.

Stiles, George Warren, September, 1912.
Superintendent, Fitchburg Gas & Electric Light Company, Fitchburg, Massachusetts.

Stiles, Harry Bacon, October, 1906.
Purchasing Agent, St. Paul Gas Light Company, Sixth and Jackson Streets, St. Paul, Minnesota.

Stiles, Linford Spearing, March, 1910.
Construction Engineer, Brooklyn Union Gas Company, 176 Remsen Street, Brooklyn, New York.

Stillson, Howard G., October, 1906.
Superintendent, Boone Gas Company, Boone, Iowa.

Stilwell, John, September, 1909.
Engineer, Department of Meters, Consolidated Gas Company, 130 East 15th Street, New York, New York.

Stirzel, Jacob W., October, 1906.
Superintendent of Holder Stations and Pumping Mains, Philadelphia Gas Works, United Gas Improvement Company, 1401 Arch Street, Philadelphia, Pennsylvania.

St. John, John, September, 1909.
Secretary and Treasurer, Madison Gas & Electric Company, 120 East Main Street, Madison, Wisconsin.

Stone, C. H., March, 1911.
Manager, Gas Department, Orange County Lighting Company, 12 South Street, Middletown, New York.

Stone, Frederick W., October, 1906.
Manager, The Ashtabula Gas Company, Ashtabula, Ohio.

Strange, Harry Latimer, March, 1911. (P)
Manager, Honolulu Gas Company, Ltd., Post Office Box 1379, Honolulu, Oahu, Hawaii.

STRECKER, ALEXANDER H., October, 1906.
Consulting Engineer, Public Service Gas Company, 235 Mt. Pleasant Avenue, Newark, New Jersey.

STRING, JOSEPH S., September, 1914.
Manager, Brockton Gas Light Company, 46 Centre Street, Brockton, Massachusetts.

STROHN, C. B., October, 1906.
District Manager, Western United Gas & Electric Company, Elgin, Illinois.

STROHN, R. N., October, 1906.
Vice-President and Treasurer, Western United Gas & Electric Company, Aurora, Illinois.

STROUD, MORRIS W., October, 1906.
President, The American Gas Company, West Washington Square, Philadelphia, Pennsylvania.

STULL, C. RODMAN, March, 1909.
Assistant Manager, Kingston Gas & Electric Company, 611 Broadway, Kingston, New York.

SUCHER, THEODORE RICHARD, September, 1914.
Superintendent of Mains and Services, New Haven Gas Light Company, 80 Crown Street, New Haven, Connecticut.

SUCHOMEL, THOMAS, October, 1906.
Superintendent of Gas Works, Cedar Rapids Gas Light Company, 501 6th Avenue, Cedar Rapids, Iowa.

SULLIVAN, BEVERLY NATHANIEL, March, 1908.
Manager, Winston-Salem Light & Fuel Company, Winston-Salem, North Carolina.

SUMMERS, GEORGE, October, 1906.
Chief Engineer, Citizens Gas Company, 645 East 21st Street, Indianapolis, Indiana.

SUMNER, ARTHUR WILLIAM, March, 1913.
Gas Engineer and Manager, Grays & Tilbury Gas Company, Bank Building, Grays, Essex, England.

SWAN, GEO. J., September, 1907.
Superintendent, Consumers Light, Heat & Power Company, 214 East First Street, Topeka, Kansas.

SWANN, HARRY R., October, 1906.
Chief Inspector (*ex-Officio*), Louisville Gas & Electric Company, 654 South Floyd Street, Louisville, Kentucky.

SWEETMAN, M. M., October, 1906.
General Superintendent, Kansas Natural Gas Company, 3410 Baltimore Avenue, Kansas City, Missouri.

SWEETMAN, W. D., October, 1906.
Superintendent, Peoples Gas Light & Coke Company, 122 South Michigan Avenue, Chicago, Illinois.

TAIT, FRANK M., October, 1906.
President, The Dayton (Ohio) Power & Light Company, 54 Wall Street, New York, New York.

TALBOTT, FRANK, October, 1906.
Superintendent and Treasurer, City of Danville Water & Light Department, Main Street, Danville, Virginia.

TAUSSIG, J. HAWLEY, October, 1906.
Engineer of Design, The United Gas Improvement Company, Broad and Arch Streets, Philadelphia, Pennsylvania.

TAYLOR, ALLYN CHANDLER, September, 1908.
Engineering Assistant, Allentown Gas Company, 516 Hamilton Street, Allentown, Pennsylvania.

TAYLOR, HORACE GREELEY, March, 1914.
Assistant Engineer to Agent, Lawrence Gas Company, 370 Essex Street, Lawrence, Massachusetts.

TAYLOR, JOHN BYRON, September, 1907.
Treasurer, Watertown Gas Light Company, Watertown, New York.

TAYLOR, WM. H., September, 1908.
Manager, Omaha Gas Company, 1509 Howard Street, Omaha, Nebraska.

TENNEY, ALBERT BALL, September, 1907.
Vice-President, Malden Electric Company, Malden & Melrose Gas Light Company, 201 Devonshire Street, Boston, Massachusetts.

TENNEY, CHARLES H., October, 1906.
President, Springfield Gas Company, Springfield, Massachusetts.

TERRY, H. WARREN, JR., October, 1906.
Superintendent, Northern Westchester Lighting Company, 127 Main Street, Ossining, New York.

THOMAS, CARL C., March, 1912. (P)
Professor of Mechanical Engineering, Johns Hopkins University, 114 Roland Avenue, Baltimore, Maryland.

THOMAS, CHARLES G. M., October, 1906.
President, New York & Queens Electric Light & Power Company, 444 Jackson Avenue, Long Island City, New York.

THOMAS, NATHANIEL W., September, 1912.
Chief Inspector, Bureau of Gas, 1513 Centennial Avenue, Philadelphia, Pennsylvania.

THOMPSON, CLARENCE E., September, 1912.
President, Wallingford Gas Light Company, 810 Chapel Street, New Haven, Connecticut.

THOMPSON, PAUL, October, 1906.
Fifth Vice-President, The United Gas Improvement Company, Broad and Arch Streets, Philadelphia, Pennsylvania.

THOMSON, GEORGE W., October, 1906.
Assistant Manager, Philadelphia Suburban Gas & Electric Company, 6th and Welsh Streets, Chester, Pennsylvania.

THOMSON, W. H., JR., September, 1908.
General Manager, Des Moines Electric Company, 8th and Locust Streets, Des Moines, Iowa.

THORN, FREDK. GODFREY, JR., October, 1906.
Engineer of Construction, Philadelphia Gas Works, The United Gas Improvement Company, 1401 Arch Street, Philadelphia, Pennsylvania.

THUMAN, FREDERIC, September, 1907. (P)
Chief Engineer and General Manager, Humphreys & Glasgow, 38 Victoria Street, London, S. W., England.

THWING, ORRELL O., October, 1906.
Chief Engineer, Western Gas Construction Company, 3002 Thompson Avenue, Fort Wayne, Indiana.

TINCHER, T. SYMMES, September, 1911.
Superintendent of Manufacture, Washington Gas Light Company, 3918 New Hampshire Avenue, N. W., Washington, District of Columbia.

TIPPY, B. O., October, 1906.
Consulting Engineer, 710 Union Trust Building, Detroit, Michigan.

TIPPY, CHARLES W., October, 1906.
General Manager, Commonwealth Power Company, 214 West Main Street, Jackson, Michigan.

TITZEL, R. JOHN, September, 1911.
Gas Engineer, United Gas & Electric Engineering Corporation, 2100 First Avenue, Birmingham, Alabama.

TOBEY, FRANKLIN, JR., October, 1906.
Manager, Kingston Gas & Electric Company, 611 Broadway, Kingston, New York.

Tolman, William N., October, 1906.
Constructing Engineer, 813 West Fayette Street, Syracuse, New York.

Townsend, Alfred Freeman, September, 1913.
Manager, Blackstone Valley Gas & Electric Company, 3 Clinton Street, Woonsocket, Rhode Island.

Traver, Alva F., October, 1906.
Superintendent, Gas Department, Gas & Electric Company, 900 15th Street, Denver, Colorado.

Travis, Frank M., October, 1906.
Secretary, Winsted Gas Company; Treasurer, Torrington Electric Light & Gas Company, 58 Church Street, Torrington, Connecticut.

Treadway, Alfred Alanson, September, 1914.
Superintendent of Shop Department, Detroit City Gas Company, 146 Glynn Court, Detroit, Michigan.

Treleaven, L. G., September, 1907.
Receiver, Consumers Light, Heat & Power Company, 824 Kansas Avenue, Topeka, Kansas.

Trimble, James, September, 1914.
Vice-President and Manager, Sault Ste. Marie Gas & Electric Company, 419 Ashmun Street, Sault Ste. Marie, Michigan.

Tucker, C. A., October, 1906.
Assistant Treasurer, Rochester Railway & Light Company, 34 Clinton Avenue, North, Rochester, New York.

Tudbury, John Leslie, September, 1914.
Manager, Salem Gas Light Company, 247 Essex Street, Salem, Massachusetts.

Tull, Lucien P. F., October, 1906.
Accountant, New Amsterdam Gas Company, 130 East 15th Street, New York, New York.

Turner, Alfred E., September, 1912.
Assistant General Superintendent of Meters, Consolidated Gas Company, 130 East 15th Street, New York, New York.

Tuttle, W. B., October, 1906. (P)
Vice-President and General Manager, San Antonio Gas & Electric Company, 305 East Houston Street, San Antonio, Texas.

Tutwiler, Carrington Cabell, October, 1906.
Consulting Chemist, 1630 Real Estate Trust Building, Philadelphia, Pennsylvania.

UHLIG, EDWARD C., March, 1911.
Chief Chemist, Brooklyn Union Gas Company, 191 St. James Place, Brooklyn, New York.

UNDERHILL, HENRY L., September, 1908.
Assistant Engineer of Manufacture, Consolidated Gas Company of New York, Residence, 241 West 108th Street, New York, New York.

UNDERWOOD, CHARLES E., March, 1914.
General Superintendent, Allegheny By-Product Coke Company, McKeesport, Pennsylvania.

VANCE, CHAMP SHEPHERD, September, 1910. (P)
Third Vice-President, Los Angeles Gas & Electric Corporation, 645 South Hill Street, Los Angeles, California.

VAN NESS, L. G., October, 1906.
Secretary, The Merchants Power Company, 48 North Second Street, Memphis, Tennessee.

VANDER WILLIGEN, T. A., September, 1908.
Continental Representative of Humphreys & Glasgow, Ltd., 36 Victoria Street, London, S. W., England.

VINCENT, G. I., October, 1906. (P)
Engineer, Des Moines Gas Company, 412 West 7th Street, Des Moines, Iowa.

VONMAUR, JACOB D., October, 1906.
Superintendent of Distribution, Laclede Gas Light Company, 11th and Olive Streets, St. Louis, Missouri.

VON PHUL, WILLIAM, September, 1912.
Member of firm Ford, Bacon & Davis, Engineers, 921 Canal Street, New Orleans, Louisiana.

VON STARZENSKI, VICTOR, March, 1909.
Superintendent, Mohawk Gas Company, 511 State Street, Schenectady, New York.

VONVITTINGHOFF, HANS, September, 1908.
Secretary to Vice-President, Stone & Webster, 147 Milk Street, Boston, Massachusetts.

VOORHEES, ANDREW JOHN, March, 1913.
Secretary to President, Brooklyn Union Gas Company, 176 Remsen Street, Brooklyn, New York.

WAGNER, FRED H., March, 1907.
Chief Engineer, The Bartlett Hayward Company, Rogers Avenue and Pimlico Road, Station E, Baltimore, Maryland.

Wainwright, Arthur V., October, 1906.
General Manager, American Public Service Company, Abilene, Texas.

Waldron, Charles, Jr., September, 1908.
Central Hudson Gas & Electric Company, 50 Market Street, Poughkeepsie, New York.

Walker, Edwin M., October, 1906.
General Manager, Union Electric Company, Dubuque, Iowa.

Walker, M. T., October, 1906.
Manager, Beaumont Gas Light Company, Beaumont, Texas.

Wallace, R. A., October, 1906.
Superintendent, Gas Division, Quebec Railway, Light, Heat & Power Company, 10 Palace Hill, Quebec, Canada.

Wallace, Ross Strawn, March, 1913.
Second Vice-President and General Manager, Central Illinois Light Company, 316 South Jefferson Avenue, Peoria, Illinois.

Wallace, Scott Henry, September, 1912.
Assistant General Manager, St. Louis County Gas Company, Lockwood and McClure Avenues, Webster Groves, Missouri.

Walter, E. P., September, 1913.
Engineer, The United Gas Improvement Company, 2201 Venango Street, Philadelphia, Pennsylvania.

Walters, Benj. S., October, 1906.
Manager, Northern Indiana Gas & Electric Company, 571 Hohman Street, Hammond, Indiana.

Waring, Clarence H., March, 1914.
Superintendent, Wyandotte County Gas Company, 600 Minnesota Avenue, Kansas City, Kansas.

Waring, George H., October, 1906.
Vice-President and General Manager, Charleston Consolidated Railway & Lighting Company, 141 Meeting Street, Charleston, South Carolina.

Warmington, Daniel R., October, 1906.
1804 East 63d Street, Cleveland, Ohio.

Warner, George H., October, 1906.
Vice-President, William M. Crane Company, 16 West 32d Street, New York, New York.

WARNICK, JOHN H., September, 1908.
Assistant to General Superintendent, The United Gas Improvement Company, 1401 Arch Street, Philadelphia, Pennsylvania.

WATERBURY, HERBERT JESSUP, September, 1910.
Manager, Marquette Gas Light Company, Marquette, Michigan.

WATERS, JOHN A., October, 1906.
Assistant Superintendent, Gas Department, The Stamford Gas & Electric Company, 11 Bank Street, Stamford, Connecticut.

WAY, ALEXANDER B., September, 1911.
Chief Chemist, New England Gas & Coke Company, Everett, Massachusetts.

WEBBER, PAUL B., March, 1914.
Treasurer, Athol Gas & Electric Company, 78 Devonshire Street, Boston, Massachusetts.

WEBER, F. C., September, 1910.
Gas Engineer, H. L. Doherty & Company, 60 Wall Street, New York, New York.

WEBER, T. G., March, 1914.
Engineer's Assistant, Central Union Gas Company, 905 East 138th Street, New York, New York.

WEBER, THEO. J., September, 1908.
Consulting Engineer, United Light & Railway Company, 823 Michigan Trust Building, Grand Rapids, Michigan.

WEHNERT, H. C., September, 1913. (P)
Superintendent, Station A, Laclede Gas Light Company, Laclede Gas Building, 11th and Olive Streets, St. Louis, Missouri.

WEINMEISTER, CARL J., March, 1914.
Superintendent of Mains, Atlanta Gas Light Company, Electric and Gas Building, Atlanta, Georgia.

WEISGERBER, EDWIN C., October, 1906.
Representative, Equitable Meter Company, 422 First Avenue, Pittsburgh, Pennsylvania.

WELCH, JOHN S., October, 1906.
Manager, Industrial Division, The United Gas Improvement Company, 1035 Market Street, Philadelphia, Pennsylvania.

WELSH, WILLIAM J., October, 1906. (P)
President and Manager, New York & Richmond Gas Company, 691 Bay Street, Stapleton, Staten Island, New York.

WEPFER, WILLIAM MACKNESS, March, 1914.
Chief Draftsman, Brooklyn Union Gas Company, 176 Remsen Street, Brooklyn, New York.

WERNER, LOUIS H., September, 1910. (P)
Secretary, Central Union Gas Company, 519 Courtlandt Avenue, New York, New York.

WESTCOTT, JOHN TOWNSEND, October, 1906.
Consulting Engineer, 11 Strawberry Hill Road, Twickenham, London, England.

WESTON, EDGAR C., September, 1912.
Superintendent, Gas Light Company, 240 Court Street, Middletown, Connecticut.

WHEELER, FRED B., October, 1906.
Gas Engineer, Stepney Depot, Connecticut.

WHIPPLE, HENRY S., October, 1906.
Manager, Rockford Gas Light & Coke Company, 201 Mulberry Street, Rockford, Illinois.

WHITCOMB, H. D., October, 1906.
Vice-President and General Manager, Public Service Gas Company, Broad and Bank Streets, Newark, New Jersey.

WHITE, ALFRED H., September, 1909.
Professor of Chemical Engineering, University of Michigan, 715 Church Street, Ann Arbor, Michigan.

WHITE, HOWARD EDMUND, March, 1915.
Assistant Superintendent, New Haven Gas Light Company, 80 Crown Street, New Haven, Connecticut.

WHITE, JOHN T., March, 1911.
Superintendent of Street Main Department, Brooklyn Union Gas Company, 176 Remsen Street, Brooklyn, New York.

WHITELEY, BENJAMIN, September, 1908.
Assistant Treasurer, Consolidated Gas Company of New York, 130 East 15th Street, New York, New York.

WHITNEY, ROY FOXWELL, March, 1910.
Manager and Treasurer, Peoples Gas & Electric Company, 70 East First Street, Oswego, New York.

WHITTAKER, ALAN DEAN, October, 1910.
Superintendent of Works, Atlanta Gas Light Company, 38 Thurmond Street, Atlanta, Georgia.

WHITTON, W. H., October, 1906. (P)
Secretary and Treasurer, Laclede Gas Light Company, 11th and Olive Streets, St. Louis, Missouri.

WHITWELL, L. M., March, 1909.
General Superintendent, Semet-Solvay Company, Syracuse, New York.

WHITWELL, SANFORD N., September, 1912.
General Auditor, Washington Gas Light Company, 413 10th Street, N. W., Washington, District of Columbia.

WHYSALL, GEORGE, October, 1906.
Consulting Engineer, Hamilton (Ontario) Gas Light Company, Marion, Ohio.

WILDE, CHARLES, March, 1908.
Engineer of Mains, Philadelphia Suburban Gas & Electric Company, 6th and Welsh Streets, Chester, Pennsylvania.

WILDER, STUART, September, 1912.
Vice-President and General Manager, Northern Westchester Lighting Company, First Avenue and First Street, Mt. Vernon, New York.

WILEY, LYMAN A., March, 1910.
Secretary, Peoples Gas Light & Coke Company, 122 South Michigan Avenue, Chicago, Illinois.

WILKE, ARNO C., March, 1909.
Chemist, Milwaukee Gas Light Company, 25th Street and St. Paul Avenue, Milwaukee, Wisconsin.

WILKINSON, A. L., October, 1906.
Treasurer, National Gas, Electric Light & Power Company, 1714 Ford Building, Detroit, Michigan.

WILLARD, FRED A., March, 1907.
Manager, McAlester Gas & Coke Company, McAlester, Oklahoma.

WILLIAMS, EDWIN H., October, 1906.
Manager, The Waterbury Gas Light Company, Waterbury, Connecticut.

WILLIAMS, HERBERT G., October, 1906.
400 Essex Avenue, Orange, New Jersey.

Williams, Luther S., October, 1906.
Manager, Harrisburg Gas Company, 1523 North 2d Street, Harrisburg, Pennsylvania.

Williams, William L., October, 1906.
Engineer (Retired), Public Service Gas Company, 63 Twelfth Avenue, Paterson, New Jersey.

Williamson, John, October, 1906.
First Vice-President and Consulting Engineer, Peoples Gas Light & Coke Company, 122 South Michigan Avenue, Chicago, Illinois.

Willis, Charles Moore, March, 1907.
Manager, Peoples Gas & Electric Company, Chillicothe, Missouri.

Wills, John Valentine, September, 1911.
Superintendent of Gas Works, Indiana Lighting Company, 1011 Old Fort Street, Fort Wayne, Indiana.

Wilson, G. J., October, 1906.
Fort Tryon Hall, 196th Street and Fort Washington Avenue, New York, New York.

Wilson, H. H., March, 1907.
Manager, Wausau Gas Company, 401 Fourth Street, Wausau, Wisconsin.

Wilson, Rodney M., September, 1912.
Chief Draughtsman, Department of Mains and Services, Consolidated Gas Company of New York, 130 East 15th Street, New York, New York.

Wilson, W. A., October, 1906.
Superintendent, Rockford Gas Light & Coke Company, Rockford, Illinois.

Wing, John Franklin, March, 1908.
Superintendent, Everett Station, Boston Consolidated Gas Company, Everett, Massachusetts.

Witherby, Edwin C., October, 1906.
General Superintendent, Semet-Solvay Company, Syracuse, New York.

Witherby, Edwin E., October, 1906.
New England Representative, Gas Machinery Company, Boston, Massachusetts; East Harpswell, Maine.

Wolff, Samuel E., October, 1906.
Care of Hodenpyl, Hardy & Company, 14 Wall Street, New York, New York.

Wood, William Austin, October, 1906. (P)
First Vice-President and Engineer-in-Chief, Boston Consolidated Gas Company, 24 West Street, Boston, Massachusetts.

WOOD, WILLIAM MUSGRAVE, September, 1907.
Department of Second Vice-President, The United Gas Improvement Company, 1401 Arch Street, Philadelphia, Pennsylvania.

WOODALL, GEORGE HERBERT, September, 1908.
General Manager and Engineer, Brooklyn Borough Gas Company, Surf Avenue and West 12th Street, Coney Island, New York.

WOODS, GEORGE E., October, 1906.
Assistant Chief Engineer, Consolidated Gas Company of New York, 130 East 15th Street, New York, New York.

WORTENDYKE, I. F., October, 1906.
Superintendent, New Gas Light Company, 7 North Main Street, Janesville, Wisconsin.

WORTHING, LEIGH E., September, 1911.
Experimental Engineer, Detroit City Gas Company, Gas Office Building, Detroit, Michigan.

WRIGHT, W. H., October, 1906.
Engineer, Citizens Gas Company of Indianapolis, 2734 North Pennsylvania Street, Indianapolis, Indiana.

WRIGHTINGTON, EDGAR N., October, 1906.
Secretary and Manager, Commercial Department, Boston Consolidated Gas Company, 24 West Street, Boston, Massachusetts.

WUEST, HENRY ANDREW, September, 1908.
Chief Clerk, Brooklyn Union Gas Company, Foot North 12th Street, Brooklyn, New York.

WYANT, ROBERT E., October, 1906.
Engineer, New Haven Gas Light Company, 80 Crown Street, New Haven, Connecticut.

WYER, SAMUEL S., September, 1915.
Consulting Engineer, Harrison Building, Columbus, Ohio.

WYMAN, WALTER S., September, 1912.
Treasurer and General Manager, Central Maine Power Company, 311 Water Street, Augusta, Maine.

YOUNG, ALFRED W., October, 1906.
General Manager, Knoxville Gas Company, Knoxville, Tennessee.

YOUNG, EDWIN S., March, 1915. (P)
Secretary, New York Mutual Gas Light Company, 142 East 15th Street, New York, New York.

YOUNG, JOHN T., March, 1907.
General Manager, Grand Rapids Gas Light Company, Grand Rapids, Michigan.

YOUNG, PERCY S., October, 1906.
Comptroller, Public Service Gas Company, 763 Broad Street, Newark, New Jersey.

YOUNG, PETER, October, 1906.
Gas Department, Watertown Light & Power Company, 135 Flower Street, Watertown, New York.

YOUNG, R. R., October, 1906.
New Business Agent, Public Service Gas Company, Broad and Bank Streets, Newark, New Jersey.

YOUNG, ROBERT W. H., March, 1911.
Superintendent, Consolidated Gas Company, 3300 Second Avenue, Pittsburgh, Pennsylvania.

ZEEK, CHARLES F., October, 1906.
Superintendent, Pensacola Gas Company, 27 East Garden Street, Pensacola, Florida.

Total Active Members..................1,111

ASSOCIATE MEMBERS.

AHLBRANDT, G. F., March, 1913.
Metallurgical Engineer, American Rolling Mill Company, Middletown, Ohio.

AIKIN, HUGH CARLON, October, 1906.
Eastern Sales Manager, Eclipse Gas Stove Company, 1016 Madison Street, Chester, Pennsylvania.

ANNETT, EDWARD BURDETT, September, 1911.
Inspector of Gas, Public Utility Commission, State of New Jersey, 790 Broad Street, Newark, New Jersey.

ASENDORF, CARL F., October, 1906.
Representative, American Meter Company, 38 South Jefferson Street, Chicago, Illinois.

ATWATER, C. G., October, 1906.
Engineer, American Coal Products Company, 17 Battery Place, New York, New York.

AZOY, ANASTASIO C. M., October, 1906.
Manager, Berwind-White Coal Mining Company, 1 Broadway, New York, New York.

BABCOCK, CHARLES B., September, 1915. (P)
Manager, General Gas Light Company, 768 Mission Street, San Francisco, California.

BALDWIN, ABRAM T., September, 1912.
President and General Manager, Precision Instrument Company, 102 Randolph Street, Detroit, Michigan.

BALZ, GEORGE ADAM, March, 1911.
Manager, Didier-March Company, Gas Engineers, Perth Amboy, New Jersey.

Barbour, William Tefft, October, 1906.
President, Detroit Stove Works, 1320 Jefferson Avenue, Detroit, Michigan.

Barnes, William Wallace, March, 1914.
Manufacturer, Bayley & Sons, Inc., 101 Park Avenue, New York, New York.

Beaumont, Robert Herbert, September, 1915.
President, R. H. Beaumont Company, 1043 Drexel Building, Philadelphia, Pennsylvania.

Behrend, F., March, 1915.
Importer of Purifying Material, Fire Brick, Etc., 54 Front Street, New York, New York.

Berry, F. K., October, 1906.
President, A. B. Stove Company, Battle Creek, Michigan.

Bettle, William H., March, 1908.
Superintendent, Appliance Department, Century Stove & Manufacturing Company, 629 Oregon Street, Santa Monica, California.

Bigelow, Lucius Seymour, October, 1906.
Editor, *The Gas Industry,* 64 Pearl Street, Buffalo, New York.

Bingham, R. W., October, 1906.
Contract Agent, Welsbach Street Lighting Company of America, Peoples Gas Building, Chicago, Illinois.

Boothe, George P., October, 1906.
Superintendent, S. R. Dresser Manufacturing Company, Boylston Street, Bradford, Pennsylvania.

Braun, Charles A., March, 1914.
Sales Agent, Stonega Coke & Coal Company, 629 Real Estate Trust Building, Philadelphia, Pennsylvania.

Brill, Alfred P., October, 1906.
General Manager, Ruud Manufacturing Company, 29th and Smallman Streets, Pittsburgh, Pennsylvania.

Brown, William Laird, September, 1912.
Assistant Manager, Helme & McIlhenny, 1339 Cherry Street, Philadelphia, Pennsylvania.

Bunnell, Sterling H., October, 1906.
Engineer-in-Chief, Griscom-Russell Company, 90 West Street, New York, New York.

Caldwell, Jas. Henry, September, 1909.
President, Ludlow Valve Company, Troy, New York.

Carlisle, Edgar G., September, 1914.
Secretary, Blair Parke Coal & Coke Company, 1618 Real Estate Trust Building, Philadelphia, Pennsylvania.

CARPENTER, FRANK, March, 1911.
Special Representative, Welsbach Gas Lamp Company, 392 Canal Street, New York, New York.

CARPENTER, H. A., October, 1906.
Vice-President, Riter-Conley Manufacturing Company, Leetsdale, Pennsylvania.

CARTWRIGHT, HENRY R., October, 1906.
Manager, Philadelphia Factory, American Meter Company, Arch and 22d Streets, Philadelphia, Pennsylvania.

CARTY, ANDREW JACKSON, March, 1915.
Wholesale Coal, 711 Stephen Girard Building, Philadelphia, Pennsylvania.

CAVENAGH, FRANK, March, 1911. (P)
General Sales Agent, Pacific Meter Company, 732 Title Insurance Building, Los Angeles, California.

CHAPIN, EDWIN S., March, 1908.
Vice-President, Welsbach Gas Lamp Company, 392 Canal Street, New York, New York.

CHEESMAN, FRANK P., October, 1906.
Partner, Cheesman & Elliot, 100 William Street, New York, New York.

CHISHOLM, CHARLES T., October, 1906.
Traveling Representative, General Gas Light Company, Kalamazoo, Michigan.

CHURCH, SUMNER ROLLIN, March, 1915.
Manager, Research Department, Barrett Manufacturing Company, 17 Battery Place, New York, New York.

CLADER, WILLIAM A., March, 1912. (P)
Certified Public Accountant, 1131 Land Title Building, Philadelphia, Pennsylvania.

CLAIBORNE, CHAS. H., March, 1909.
General Sales Manager, Union Mining Company, Manufacturers Mount Savage Fire Brick, 1113 Fidelity Building, Baltimore, Maryland.

CLARK, CHARLES J., March, 1911.
Vice-President, Hunter & Dickson Company, 245 Arch Street, Philadelphia, Pennsylvania.

CLARK, ROBERT KEEP, March, 1914.
Assistant Manager, George M. Clark & Company Division, 179 North Michigan Avenue, Chicago, Illinois.

CONROY, JAMES P., March, 1913.
Manager, General Gas Light Company, 46 West Broadway, New York, New York.

COOKE, HORACE G., September, 1913.
Sales Agent, Connersville Blower Company, 114 Liberty Street, New York, New York.

CORBUS, F. G., October, 1906.
Superintendent, Retail Departments, Welsbach Company, Gloucester City, New Jersey.

CRESSLER, ALFRED M., October, 1906.
Treasurer, The Kerr Murray Company, 1708 North Collins Street, Joliet, Illinois.

CRESSLER, GEORGE H., October, 1906.
Walker & Cressler, First National Bank Building, Chicago, Illinois.

CURFMAN, FLOYD G., September, 1914.
Sales Manager, Steere Engineering Company, Greenwood Avenue and Belt Line Railroad, Detroit, Michigan.

DALY, DAVID R., October, 1906.
Vice-President and General Manager, J. H. Gautier & Company, Green and Essex Streets, Jersey City, New Jersey.

DEHART, J. S., JR., October, 1906.
President, Isbell-Porter Company, 46 Bridge Street, Newark, New Jersey.

DICKEY, EDMUND S., October, 1906.
Member of Charles H. Dickey & Company, Guilford Avenue and Saratoga Street, Baltimore, Maryland.

DOUGHERTY, CHARLES, September, 1910.
Air Compressor and Pneumatic Tool Salesman, Ingersoll-Rand Company, 11 Broadway, New York, New York.

DREWSON, JOHN, March, 1914.
Superintendent of By-Product Coke Ovens, Woodward Iron Company, Woodward, Alabama.

EARNSHAW, WARNER G., September, 1908.
General Sales Manager, Barnes & Tucker Company, 718 Harrison Building, Philadelphia, Pennsylvania.

EISENMAN, F. N., September, 1908.
District Sales Manager, Gulf Refining Company, 185 Devonshire Street, Boston, Massachusetts.

ELMER, CHARLES BLISS, September, 1913.
Vice-President and Treasurer, General Gas Appliance Company, 103 Park Avenue, New York, New York.

Esau, Ralph, October, 1906.
Manager of Sales, Barrett Manufacturing Company, 1200 Otis Building, Chicago, Illinois.

Fairchild, Samuel E., Jr., September, 1912.
President, Cruse-Kemper Company, Ambler, Pennsylvania; 6910 West Wissahickon Avenue, Mt. Airy, Philadelphia, Pennsylvania.

Felix, Otto F., March, 1915.
Secretary and Treasurer, Equitable Meter Company, 422 First Avenue, Pittsburgh, Pennsylvania.

Foersterling, Dr. H., September, 1909.
Second Vice-President, Roessler & Hasslacher Chemical Company, 357 High Street, Perth Amboy, New Jersey.

Fowler, J. Scott, October, 1906.
Vice-President and Treasurer, Deily & Fowler Manufacturing Company, 39 Laurel Street, Philadelphia, Pennsylvania.

Frampton, R. C., March, 1907. (P)
President, Pittsburgh Water Heater Company, Pittsburgh, Pennsylvania.

Francisco, Ellsworth, September, 1913. (P)
Inspector of Gas and Gas Meters, City Hall Annex, Newark, New Jersey.

Fritz, H. C., March, 1909.
Manager, Schneider & Trenkamp Division, American Stove Company, Cleveland, Ohio.

Garrison, John J., October, 1906.
Vice-President, Rathbone, Sard & Company, North Ferry Street, Albany, New York.

Goodman, Patrick, October, 1906.
Manager, Safety Gas Main Stopper Company, 257 East 133d Street, New York, New York.

Gribbel, W. Griffin, September, 1912. (P)
Assistant Manager, J. J. Griffin & Company, 1513 Race Street, Philadelphia, Pennsylvania.

Guitteau, William Standart, September, 1914.
Sales Manager, Stacey Brothers Gas Construction Company, Station P, Cincinnati, Ohio.

Hamerstrom, Frederick Nathan, March, 1911.
Commercial Department, Welsbach Company, Ellis and Mercer Streets, Gloucester, New Jersey.

Harper, H. D., October, 1906.
Western Manager, American Meter Company, 1811 Peoples Gas Building, Chicago, Illinois.

Hatton, Richard D., March, 1914.
Vice-President and General Manager, Laclede-Christy Clay Products Company, 5900 Manchester Avenue, St. Louis, Missouri.

Hayward, E. Bartlett, March, 1907.
President, The Bartlett Hayward Company, Scott and McHenry Streets, Baltimore, Maryland.

Hayward, Sterling F., October, 1906. (P)
Treasurer, Connelly Iron Sponge & Governor Company, 127 Duane Street, New York, New York (8 Dana Street, Cambridge, Massachusetts).

Henry, William G., October, 1906.
Vice-President, Detroit Stove Works, Detroit, Michigan.

Herbert, Frederick D., September, 1911.
New York Sales Manager, Terry Steam Turbine Company, 90 West Street, New York, New York.

Hicks, George Cleveland, Jr., October, 1906.
Vice-President and Mechanical Engineer, P. H. & F. M. Roots Company, Box 165, Connersville, Indiana.

Higgins, C. M., October, 1906.
Representative, The Standard Oil Company, 26 Broadway, New York, New York.

Hinman, Walter Hibbard, March, 1911.
With United States Cartridge Company, Lowell, Massachusetts.

Hobdell, George, October, 1906.
Manager, Phoenix Meter Company, 107 Arch Street, Camden, New Jersey.

Hohmann, August B., September, 1911.
Sales Manager, C. J. Tagliabue Manufacturing Company, Bush Terminal, 32 33d Street, Brooklyn, New York.

Hornsey, John W., September, 1910.
Consulting Engineer, Summit, New Jersey.

Hubbs, John Henry, September, 1908.
Assistant Purchasing Agent, The United Gas Improvement Company, Broad and Arch Streets, Philadelphia, Pennsylvania.

Hutchinson, William P., March, 1912. (P)
Vice-President and Sales Manager, Sprague Meter Company, 205 Water Street, Bridgeport, Connecticut.

Hyde, Edward P., March, 1910.
Director, Physical Laboratory, National Electric Lamp Association, General Electric Company, Post Office Box 387, Nela Park, Cleveland, Ohio.

ISBELL, CHARLES W., October, 1906.
President, Board of Directors, Isbell-Porter Company, 257 Broadway, New York, New York.

JEWETT, EDWARD HUNTTING, September, 1914.
President, Jewett, Bigelow & Brooks, 1109 Penobscot Building, Detroit, Michigan.

JOHNSTON, E. D., October, 1906.
President, P. H. & F. M. Roots Company, Connersville, Indiana.

KAHN, LAZARD, October, 1906.
Vice-President, Estate Stove Company, Hamilton, Ohio.

KANE, WILLIAM, October, 1906.
President, William Kane Manufacturing Company, 1909 Adams Street, Philadelphia, Pennsylvania.

KELLUM, BENJAMIN J., October, 1906.
Manager, Western Department, Welsbach Company, Washington Boulevard and Des Plaines Street, Chicago, Illinois.

KIRCHBERGER, MORITZ, September, 1909.
President, Crescent Burner Company, 374 Second Avenue, New York, New York.

KNIGHT, WILLIAM H., October, 1906. (P)
General Manager, Cleveland Gas Meter Company, 2180 East 65th Street, S. E., Cleveland, Ohio.

KOPPERS, HENRY, October, 1907.
President, H. Koppers Company, Constructors of By-Products and Gas Ovens, First National Bank Building, 511 Wood Street, Pittsburgh, Pennsylvania.

LANPHIER, CHARLES H., September, 1914.
Gas and Meter Inspector, City of Springfield, Illinois, City Hall, Springfield, Illinois.

LATHROP, F. A., March, 1914.
Sales Agent (Chicago Office), Youngstown (Ohio) Sheet & Tube Company, 1563 McCormick Building, Chicago, Illinois.

LAUBER, ALBERT, October, 1906.
Treasurer, Standard Meter & Manufacturing Company, 433 West 42d Street, New York, New York.

LEAKEY, NATHAN G., October, 1906.
Assistant Secretary, Michigan Ammonia Works, Detroit, Michigan.

Lemoine, Louis R., September, 1913.
President, United States Cast Iron Pipe & Foundry Company, 1421 Chestnut Street, Philadelphia, Pennsylvania.

Lewars, Charles E., September, 1915.
Superintendent, Semet-Solvay Company, Milwaukee, Wisconsin.

Lewis, Thomas L., September, 1913.
Assistant Manager of Sales, A. M. Byers Company, 235 Water Street, Pittsburgh, Pennsylvania.

Litle, Thomas J., Jr., October, 1906.
Engineer, Welsbach Company, Gloucester City, New Jersey.

Lockwood, W. A., October, 1906.
General Salesman, Ringen Stove Company, 414 South Sixth Street, St. Louis, Missouri.

Lush, Joseph, October, 1906.
President, New York Improved Meter Company, 306 East 47th Street, New York, New York.

Lyon, Edward A., September, 1908.
District Sales Manager, Gulf Refining Company, 814 Battery Park Building, New York, New York.

McClellan, John W., September, 1908.
Vice-President and General Manager, Manhattan Gas Heating Company, 909 Seventh Avenue, New York, New York.

McCoy, William P., March, 1911.
Commercial Department, Welsbach Company, Gloucester, New Jersey.

McDonald, Frederick, September, 1909.
Gas Meter Manufacturer, 991 Broadway, Albany, New York.

McIlravy, W. N., October, 1906.
Vice-President, Barrett Manufacturing Company, 17 Battery Place, New York, New York.

McKee, William, March, 1914.
Secretary, Chaplin-Fulton Manufacturing Company, 34 Penn Avenue, Pittsburgh, Pennsylvania.

McNary, John B., October, 1906.
Manager and Secretary, Canadian Meter Company, Limited, Hamilton, Ontario, Canada.

Macbeth, Norman, September, 1909.
Illuminating Engineer; Editor, *Lighting Journal*; 241 West 37th Street, New York, New York.

Mackenzie, Kenneth Gerard, March, 1914.
Consulting Chemist, The Texas Company, Bayonne, New Jersey.

Manning, W. E., March, 1914.
Secretary, Youngstown Sheet & Tube Company, Youngstown, Ohio.

Martineau, Frederick Clifford, September, 1914.
Assistant Superintendent, Street Department, Consolidated Gas Company of New York, 111th Street and First Avenue, New York, New York.

Mason, John Ambler, September, 1909.
With the Bartlett, Hayward Company, 100 Broadway, New York, New York.

Mason, Sidney, October, 1906.
President, Welsbach Company, Gloucester City, New Jersey.

Melcher, Charles W., October, 1906.
General Manager, Ingersoll-Rand Company of Illinois, Peoples Gas Building, Chicago, Illinois.

Millar, P. S., March, 1909.
General Manager, New York Electrical Testing Laboratories, 80th Street and East End Avenue, New York, New York.

Miller, Edwin Francis, September, 1914. (P)
Engineer, Camden Iron Works, Camden, New Jersey.

Miller, Fred A., October, 1906.
President and General Manager, S. R. Dresser Manufacturing Company, Boylston Street, Bradford, Pennsylvania.

Mingus, James B., March, 1910.
Sales Agent, Penn Gas Coal Company, 222 South Third Street, Philadelphia, Pennsylvania.

Mordue, Thomas N., October, 1906.
Coal Merchant, 817 Peoples Gas Building, Chicago, Illinois.

Morrell, Clarence P., October, 1906.
Wholesale Coal, Room 194, 1 Broadway, New York, New York.

Mouser, Otis, March, 1914.
Sales Manager, Stonega Coke & Coal Company, Big Stone Gap, Virginia.

Mueller, Robert, October, 1906. (P)
Secretary, H. Mueller Manufacturing Company, Decatur, Illinois.

Newbold, E. S., March, 1909.
President, American Street Lighting Company, 831 Greenmount Avenue, Baltimore, Maryland.

Nibecker, Karl, September, 1915.
Steam Engineer, Youngstown Sheet & Tube Company, Youngstown, Ohio.

Nicholls, Carroll B., October, 1906.
General Sales Agent, Westmoreland Coal Company, 224 South Third Street, Philadelphia, Pennsylvania.

Norton, Arthur E., October, 1906.
Superintendent, Nathaniel Tufts Meter Company, 455 Commercial Street, Boston, Massachusetts.

Norton, Harry A., October, 1906.
President and Manager, Nathaniel Tufts Meter Company, 455 Commercial Street, Boston, Massachusetts.

Nutty, G. R., October, 1906.
General Sales Manager, Gulf Refining Company, Frick Building Annex, Pittsburgh, Pennsylvania.

Osborne, Willard B., October, 1906.
Managing Engineer, Lowell Gas Light Company, 46 Mansur Street, Lowell, Massachusetts.

Osius, George, October, 1906.
Secretary and Treasurer, Michigan Ammonia Works, Detroit, Michigan.

Page, Edward, September, 1908.
Vice-President, New England Coal & Coke Company, 111 Devonshire Street, Boston, Massachusetts.

Papworth, Harry M., September, 1913.
Salesman and Eastern Manager, P. H. & F. M. Roots Company, 120 Liberty Street, New York, New York.

Parish, William H., March, 1913.
Sales Engineer, Westmoreland Coal Company, 224 South 3rd Street, Philadelphia, Pennsylvania.

Parker, George W., October, 1906.
Vice-President and General Manager, Russell Engineering Company, International Life Building, St. Louis, Missouri.

Parker, John F., September, 1910.
Western Sales Manager, Eclipse Gas Stove Company, Rockford, Illinois.

Patterson, Alfred R., September, 1912.
Auditor, Stone & Webster Management Association, 147 Milk Street, Boston, Massachusetts.

Pattison, Melvin, October, 1906.
General Manager of Sales, Brown Hoisting Machinery Company, 4403 St. Clair Avenue, Cleveland, Ohio.

PAYNE, F. H., October, 1906.
Manager, Metric Metal Works, 10th and Payne Streets, Erie, Pennsylvania.

PECK, HARRY G., September, 1913.
Treasurer, Gas Appliance Sales Company of America, 2227 Wood Street, Philadelphia, Pennsylvania.

PEFFLY, IRVIN W., September, 1908.
Eastern Sales Manager, George M. Clark Company, Division American Stove Company, 1493 Broadway, New York, New York.

PENFIELD, H. P., March, 1914.
Sales Manager, Ball Engine Company, 1001 Commercial Trust Building, Philadelphia, Pennsylvania.

PERKINS, ROWAN P., September, 1907.
Consulting Engineer, Hale Building, Chestnut and Juniper Streets, Philadelphia, Pennsylvania.

PERRY, A. T., October, 1906.
Vice-President, Barrett Manufacturing Company, 1317 Illuminating Building, Cleveland, Ohio.

PHILLIPS, L. R., March, 1907.
Care of National Tube Company, Room 1114, 208 South LaSalle Street, Chicago, Illinois.

PILZ, C., March, 1907.
Secretary, New York Lead Wool Company, 93 Nassau Street, New York, New York.

PISER, THEO. H., October, 1906.
Manager, Welsbach Company of New England, 16 Oliver Street, Boston, Massachusetts.

PLUCKER, HOWARD W., September, 1910.
Salesman, with I. A. Sheppard & Company, Erie Avenue and Sepviva Street, Philadelphia, Pennsylvania.

PORTER, ROLAND G., October, 1906.
Engineer, Rockford Gas Light & Coke Company, Gas Works Office, Avon Street, Rockford, Illinois.

PRENDERGAST, DANIEL J., October, 1906.
General Superintendent, Welsbach Street Lighting Company of America, 318 West 42d Street, New York, New York.

PRICE, W. W., October, 1906.
President, The Dayton Pipe Coupling Company, Edmund and Michigan Avenues, Dayton, Ohio.

Rancke, Louis N., October, 1906.
Consulting Engineer and Chemist, 45 Knickerbocker Building, Baltimore, Maryland.

Reeves, William, October, 1906.
President, The Reeves Manufacturing Company, Milford, Connecticut.

Reichhelm, Paul F., September, 1908.
Secretary, American Gas Furnace Company, 24 John Street, New York, New York.

Reinhardt, G. A., March, 1914.
Metallurgist, Youngstown Sheet & Tube Company, Youngstown, Ohio.

Reynolds, M. G., October, 1906. (P)
General Manager, Reynolds Gas Regulator Company, 1019 Delaware Street, Anderson, Indiana.

Richardson, Charles Germane, September, 1914.
Sales Engineer, Builders Iron Foundry, 9 Codding Street, Providence, Rhode Island.

Roberts, Clarence V., October, 1906.
President, Roberts & Mander Stove Company, 11th Street and Washington Avenue, Philadelphia, Pennsylvania.

Robertson, Lawrence B., March, 1915.
Superintendent of Coke Oven Department, Maryland Steel Company, P. O. Box 88, Sparrows Point, Maryland.

Rodgers, Edward H., October, 1906.
President and Treasurer, Standard Meter Company, 3112 North 17th Street, Philadelphia, Pennsylvania.

Roesch, Daniel, October, 1906.
Assistant Professor of Experimental Engineering, Armour Institute of Technology, Armour Station, 33rd and Federal Streets, Chicago, Illinois.

Rolston, Robert J., March, 1911.
Manager, Welsbach Company, 1008 Filbert Street, Philadelphia, Pennsylvania.

Rust, Robert Ripley, March, 1910.
Superintendent of Foundries, Central Foundry Company, 90 West Street, New York, New York.

Ruud, Edwin, September, 1907.
Manufacturer, Ruud Manufacturing Company, Pittsburgh, Pennsylvania.

Salt, Thomas V., September, 1910.
Vice-President and General Manager, Allegheny By-Products Coke Company, 5547 Bartlett Street, Pittsburgh, Pennsylvania.

Sanders, Barney H., September, 1912.
President and General Manager, American Foundry & Manufacturing Company, St. Louis, Missouri.

Sard, Russell E., September, 1909.
Vice-President and General Manager, Rathbone, Sard & Company, Albany, New York.

Sayer, Eugene Y., October, 1906.
Vice-President and General Manager, Improved Equipment Company, 60 Wall Street, New York, New York.

Schall, Henry D., October, 1906.
Assistant to Vice-President, Detroit Stove Works, 1320 Jefferson Avenue, East, Detroit, Michigan.

Schurz, James R., September, 1907.
General Sales Agent, Camden Coke Company, 755 Broad Street, Newark, New Jersey.

Seaver, Kenneth, September, 1913.
Chief Engineer, Harbison-Walker Refractories Company, Farmers Bank Building, Pittsburgh, Pennsylvania.

Seeger, Robert, October, 1906.
District Manager, Welsbach Street Lighting Company of America, 704 Laclede Gas Building, St. Louis, Missouri.

Shaw, Arthur E., September, 1914. (P)
President, Welsbach Street Lighting Company of America, 1934 Market Street, Philadelphia, Pennsylvania.

Sheppard, Howard R., September, 1909.
Member of firm of I. A. Sheppard & Company, 1801 North 4th Street, Philadelphia, Pennsylvania.

Sinai, Alexander, September, 1915.
Manager in New York, Lindsay Light Company, 91 Chambers Street, New York, New York.

Smith, T. J., Jr., March, 1911.
Special Sales Representative, Pittsburgh Water Heater Company, Pittsburgh, Pennsylvania.

Speller, Frank N., March, 1907.
Metallurgical Engineer, National Tube Company, Frick Building, Pittsburgh, Pennsylvania.

Sperr, Fredk. Wm., Jr., March, 1915.
Chief Chemist, Coke Oven Department, H. Koppers Company, Oakmont, Pennsylvania.

Sperry, Richard Evans, March, 1914.
Superintendent of Construction, Bartlett Hayward Company, 100 Broadway, New York, New York.

Sprague, Henry H., March, 1908. (P)
President, Sprague Meter Company, 205 Water Street, Bridgeport, Connecticut.

Stacey, Andrew J., October, 1906.
Vice-President, The Stacey Bros. Gas Construction Company, Station P., Cincinnati, Ohio.

Stacey, James E., October, 1906.
President, The Stacey Bros. Gas Construction Company, Station P, Cincinnati, Ohio.

Stevens, Chester N., September, 1915. (P)
Assistant to Vice-President, Barrett Manufacturing Company, 17 Battery Place, New York, New York.

Stites, Townsend, September, 1907.
General Manager, Welsbach Company, Gloucester, New Jersey.

Stone, Thomas W., October, 1906.
Engineer, Western Gas Construction Company, 919 Columbia Avenue, Fort Wayne, Indiana.

Storrs, Aaron Putnam, March, 1908.
President, Storrs Mica Company, Owego, New York.

Storrs, Charles P., October, 1906.
Secretary, Storrs Mica Company, Owego, New York.

Strause, Louis J., March, 1914.
Secretary and Treasurer, Strause Gas Iron Company, 1425 Vine Street, Philadelphia, Pennsylvania.

Sullivan, Edward J., March, 1908.
Firm of Sullivan Brothers, 45 Main Street, Flushing, Long Island, New York.

Sullivan, William H., March, 1908.
Firm of Sullivan Brothers, 45 Main Street, Flushing, Long Island, New York.

Taplin, Frank E., October, 1906.
President, Cleveland & Western Coal Company, Leader-News Building, Cleveland, Ohio.

Tatman, J. S., March, 1911.
With Connersville Blower Company, Connersville, Indiana.

Thompson, Robert John, September, 1914. (P)
Manager, Welsbach Company, 863 Mission Street, San Francisco, California.

Timm, Charles F., March, 1911.
Salesman, Wm. M. Crane & Company, 16 West 32d Street, New York City; 46 Point Street, Yonkers, New York.

Tripp, Frank Foster, September, 1913.
Treasurer and General Manager, Automatic Gas Lighting Supply Company, 64 Warren Street, Roxbury, Massachusetts.

Tufts, Bowen, September, 1912.
Director, various gas companies, 78 Devonshire Street, Boston, Massachusetts.

Unger, John Samuel, March, 1914.
Mechanical and Chemical Engineer (Builder of the Unger Ammonia Still), 3344 Broadway, Chicago, Illinois.

Van Wie, Edwin G., October, 1906.
Superintendent, Gas Appliance Department, Detroit Stove Works, 1320 Jefferson Avenue, Detroit, Michigan.

Van Winkle, Walter H., September, 1913.
Vice-President, Water Works Equipment Company, 50 Church Street, New York, New York.

Wardell, Chas. W., September, 1909.
Illuminating Engineer, Welsbach Company, Gloucester, New Jersey.

Warren, Henry J., October, 1906.
President, Stamford Gas Stove Company, Box 388, Stamford, Connecticut.

Way, John G., March, 1909.
Manager, New Process Stove Company Division, American Stove Company, 4415 Perkins Avenue, Cleveland, Ohio.

Weber, Albert J., October, 1906.
President, Adam Weber Sons, Manhattan Club, 26th and Madison Avenues, New York, New York.

Wehner, Robert K., October, 1906.
Treasurer, Isbell-Porter Company, Bridge and Ogden Streets, Newark, New Jersey.

Weller, William W., September, 1913.
Manager of Sales, A. M. Byers Company, 235 Water Street, Pittsburgh, Pennsylvania.

Wells, Fred K., October, 1906.
Manager, Pittsburgh Water Heater Company of Massachusetts, 69 Broad Street, Boston, Massachusetts.

Wentz, Daniel B., March, 1914.
President, Stonega Coke & Coal Company (Virginia), 1727 Land Title Building, Philadelphia, Pennsylvania.

Westermaier, Francis Victor, October, 1906. (P)
Engineer, Welsbach Street Lighting Company of America, 1934 Market Street, Philadelphia, Pennsylvania.

Wharton, Henry, October, 1906.
Chestnut Hill Station, Philadelphia, Pennsylvania.

Whetstone, Walter, September, 1914.
President, Whetstone & Company, Inc., 911 Filbert Street, Philadelphia, Pennsylvania.

Whitaker, M. C., October, 1906.
Professor, Mechanical Science, Columbia University, New York, New York.

Wickham, Leigh, October, 1906.
Sales Agent, Parker-Russell Mining & Manufacturing Company, 603 Laclede Gas Building, St. Louis, Missouri.

Wilputte, Louis, March, 1913.
Vice-President and General Manager, Otto Coking Company, 6 Church Street, New York, New York.

Wilson, Edwards F., October, 1906.
Chief Chemist, Westmoreland Coal Company, Irwin, Pennsylvania.

Wilson, John Crosier, September, 1911.
Engineer, Thomas Meter Department, Cutler-Hammer Manufacturing Company, 12th Street and St. Paul Avenue, Milwaukee, Wisconsin.

Witte, Louis A., September, 1913.
Construction Engineer, Didier-March Company, Post Office Box 327, Perth Amboy, New Jersey.

Wood, Edward R., Jr., October, 1906.
Executor, 401 Chestnut Street, Philadelphia, Pennsylvania.

Young, L. B., October, 1906. (P)
General Manager, The Michigan Stove Company, 1022 Jefferson Avenue, East, Detroit, Michigan.

Young, N. A., March, 1909.
Secretary, James Gardner, Jr., Company, Lincoln Street, Bolivar, Pennsylvania.

Youngman, Robert H., September, 1910.
Assistant to President, Harbison-Walker Refractories Company, 1816 Farmers Bank Building, Pittsburgh, Pennsylvania.

Zitzewitz, Hermann, October, 1906.
President, National Machine Works, Sheffield and North Avenues, Chicago, Illinois.

Total Associate Members 218

JUNIOR MEMBERS.

ALBURGER, ELMER R., September, 1908.
Constructor, The United Gas Improvement Company, Broad and Arch Streets, Philadelphia, Pennsylvania.

BALDWIN, FREDERICK R., September, 1912.
Superintendent's Assistant, Brooklyn Union Gas Company, 150 Sixth Avenue, Brooklyn, New York.

BAXTER, EDW. O., September, 1908.
Chief Clerk, Westchester Lighting Company, 67 North Broadway, Yonkers, New York.

BAYLIE, WILLIAM PERCIVAL, September, 1913.
Inspector of Accounts, Distribution Department, Philadelphia Gas Works, 24 North 22d Street, Philadelphia, Pennsylvania.

BEEBE, THOMAS RUSSELL, September, 1907.
Commercial Engineer, Oxweld Acetylene Company, 1417 Morse Avenue, Chicago, Illinois.

BENNITT, GEORGE E., September, 1913.
Engineer's Assistant, Department of Utilization, Consolidated Gas Company of New York, 220 South Ninth Avenue, Mount Vernon, New York.

BERTOLETTE, NORMAN BOONE, September, 1914.
Division Engineer, Philadelphia Suburban Gas & Electric Company, Post Office Box B, Wyncote, Pennsylvania.

BUDDE, JOHN HENRY, September, 1914.
Secretary to Construction Engineer, Consolidated Gas Company of New York, 130 East 15th Street, New York, New York.

BURNETT, FREDERICK, October, 1906.
Assistant to Chief Engineer, Economical Gas Apparatus Construction Company, 165 King Street, Toronto, Ontario, Canada.

BUTLER, JOSEPH, September, 1914.
Cadet Engineer, The United Gas Improvement Company, 1711 Monument Avenue, Philadelphia, Pennsylvania.

BYRNE, THOMAS J., September, 1912.
Superintendent's Assistant, Consolidated Gas Company of New York, 501 East 21st Street, New York, New York.

CALL, ALMON EUGENE, September, 1912.
Assistant Engineer of Tests, Island Creek Coal Sales Company, 511 Plymouth Building, Minneapolis, Minnesota.

CALLAHAN, CORNELIUS F., September, 1913.
Superintendent of Construction, Nassau & Suffolk Lighting Company, 52 Vancott Avenue, Hempstead, Long Island, New York.

Callahan, John Joseph, March, 1911.
Foreman, New York & Richmond Gas Company, 694 Bay Street, Stapleton, Staten Island, New York.

Callaway, George Samuel, September, 1912.
Superintendent's Assistant, Equity Works, Brooklyn Union Gas Company, Maspeth and Porter Avenues, Brooklyn, New York.

Canon, Frank Ashton, March, 1914.
Chemist, The United Gas Improvement Company, 6221 Ogontz Avenue, Philadelphia, Pennsylvania.

Carter, Charles Freeman, March, 1913.
Cadet Engineer, Savannah Gas Company, 9 Congress Street West, Savannah, Georgia.

Cheeseman, Clyde Edward, March, 1915.
Superintendent's Assistant, Brooklyn Union Gas Company, 556 Kent Avenue, Brooklyn, New York.

Chidsey, Raymond F., September, 1911.
Assistant Manager, Kingston Gas & Electric Company, 611 Broadway, Kingston, New York.

Cloen, Fred, March, 1914.
General Superintendent, Paducah Light & Power Company, 406 Broadway, Paducah, Kentucky.

Coles, Sidney S., September, 1913.
Assistant to Engineer, Westchester Lighting Company, 1st Avenue and 1st Street, Mount Vernon, New York.

Collester, Earl H., March, 1915.
Superintendent, Coke Ovens, La Belle Iron Works, Steubenville, Ohio.

Collier, Edward Carlton, March, 1913.
New Business Manager, Missoula Gas Company, 126 West Main Street, Missoula, Montana.

Colton, Francis, March, 1914.
Assistant to Engineer, Public Service Construction Company, Ponce, Porto Rico.

Coombs, Fred S., October, 1906.
Superintendent, Meter Department, Youngstown Consolidated Gas & Electric Company, Post Office Box 58, Youngstown, Ohio.

Cotton, Francis Joseph, March, 1914.
Superintendent's Assistant, Astoria Light, Heat & Power Company, Astoria, Long Island, New York.

Cozzens, John Howard, March, 1915.
Superintendent's Assistant, Holder Distribution Department, Brooklyn Union Gas Company, 176 Remsen Street, Brooklyn, New York.

Crankshaw, J. Ward, March, 1910.
Allentown Gas Company, Allentown, Pennsylvania.

Crouse, William Thomas, March, 1914.
Assistant Superintendent of Stores, The United Gas Improvement Company, 19th Street and Allegheny Avenue, Philadelphia, Pennsylvania.

Crowell, Hugh Ramsay, September, 1914.
Engineer's Assistant, Consolidated Gas Company of New York, 80 Elizabeth Street, New York, New York.

Crowell, James Kenneth, September, 1908.
Assistant to Engineer, Westchester Lighting Company, North Main Street, Portchester, New York.

Davis, Edgar B., March, 1909.
Cadet, Distribution Department, Westchester Lighting Company, 134 South 11th Avenue, Mt. Vernon, New York.

Dickey, Philip S., March, 1912.
Foreman, Fitting Shop, Beloit Water, Gas & Electric Company, 429 East Grand Avenue, Beloit, Wisconsin.

Duncan, Howard William, September, 1912.
402 Pine Street, Hammond, Indiana.

Eichengreen, Leon B., March, 1913.
Assistant to General Superintendent, The United Gas Improvement Company, 1401 Arch Street, Philadelphia, Pennsylvania.

Ellis, R. L., March, 1913.
Superintendent, Selma Lighting Company, Selma, Alabama.

Felton, John Garrett, March, 1912.
Superintendent, Electric Department, Charleston Consolidated Railway & Lighting Company, Charleston, South Carolina.

Field, Horace Hopkins, September, 1911.
163 Lenox Avenue, Providence, Rhode Island.

Fitzpatrick, Daniel, October, 1906.
Foreman of Works, St. Augustine Gas & Electric Light Company, St. Augustine, Florida.

Ford, Andrew Joseph, September, 1914.
District Draftsman, Consolidated Gas Company of New York, 96 South 11th Street, Newark, New Jersey.

Ford, Charles McCabe, March, 1913.
Chief Clerk and Assistant General Foreman, Brooklyn Union Gas Company, 176 Remsen Street, Brooklyn, New York.

FOX, CHARLES J., October, 1906.
Superintendent of Distribution, Philadelphia Suburban Gas & Electric Company, 867 Main Street, Darby, Pennsylvania.

GALLIGAN, JAMES EDWARD, March, 1914.
General Foreman of Mains, Westchester Lighting Company, 127 Convent Place, Yonkers, New York.

GALLOWAY, JAMES WESLEY, March, 1915.
Experimental Plant, The United Gas Improvement Company, 5526 Addison Street, Philadelphia, Pennsylvania.

GELLERT, NATHAN H., March, 1911.
Constructing Gas Engineer, Colchester, Connecticut.

GIBBS, TUCKER CARRINGTON, March, 1914.
Manager, Gibbs Gas Engine Company, Jacksonville, Florida.

GIBSON, JAMES COE, September, 1912.
Secretary-Treasurer and Manager, Labette Gas Company, Chetopa, Kansas.

GONZALEZ, AMERICO RODRIGUEZ, March, 1913.
Havana, Cuba.

GRANT, ALBERT WESTON, JR., September, 1913.
Photometric Department, The United Gas Improvement Company, 1401 Arch Street, Philadelphia, Pennsylvania.

GREEN, ALBERT, October, 1906.
General Foreman of Fitters, The United Gas Improvement Company, 4251 Romain Street, Philadelphia, Pennsylvania.

GREEN, J. W., October, 1906.
Superintendent, Westchester Lighting Company, First Avenue and First Street, Mount Vernon, New York.

GREENE, RAYMOND LEWIS, March, 1913.
Assistant Superintendent, Brooklyn Union Gas Company, 556 Kent Avenue, Brooklyn, New York.

GRIFFIN, ORANGE G., September, 1913.
Draughtsman, Consolidated Gas Company, 1854 Seventh Avenue, New York, New York.

Griffis, Rowland Elliot, September, 1913.
Inspector of Traffic Handling, Philadelphia Gas Works, The United Gas Improvement Company, 24 North 22d Street, Philadelphia, Pennsylvania.

Griffiths, Chester A. A., March, 1914.
Engineer's Assistant, Consolidated Gas Company of New York, 130 East 15th Street, New York, New York.

Griffiths, Norman James, September, 1913.
Statistical Clerk, Consolidated Gas Company, 130 East 15th Street, New York, New York.

Gross, Harry O., September, 1909.
Chief Clerk, Transportation Division, The United Gas Improvement Company, 4650 Market Street, Philadelphia, Pennsylvania.

Haldeman, Clifford L., September, 1911.
Works Department, Philadelphia Gas Works, The United Gas Improvement Company, 2920 North 26th Street, Philadelphia, Pennsylvania.

Hamilton, Earl R., September, 1911.
Chemical Engineer, Fall River Gas Works Company, 155 North Main Street, Fall River, Massachusetts.

Hammond, Eric W., October, 1906.
Superintendent of Meter Repair Shop, Kansas City Gas Company, 910 Grand Avenue, Kansas City, Missouri.

Hansen, Alfred H., September, 1912.
Tar Salesman, Omaha Gas Company, 416 Woolworth Avenue, Omaha, Nebraska.

Haralson, James M., March, 1915.
Engineering Assistant, Utilization Department, Consolidated Gas Company, 130 East 15th Street, New York, New York.

Hartsock, L. H., March, 1915. (P)
District Manager, Pacific Gas & Electric Company, 120 Fifth Street, Colusa, California.

Harriman, Herbert E., September, 1912.
Superintendent of Works, Bangor Gas Light Works, 349 Main Street, Bangor, Maine.

Harris, Alan Hale, Jr., September, 1914.
Engineer, Coal Products Manufacturing Company, Joliet, Illinois.

Hayward, Harold A., March, 1911. (P)
Assistant General Manager, Connelly Iron Sponge & Governor Company, 127 Duane Street, New York, New York.

Heavner, LeRoy Clements, March, 1911.
Engineer, Tampa Gas Company, Tampa, Florida.

HELMAN, HIRAM, September, 1913.
Superintendent of Distribution, Gardner Gas Fuel & Light Company, Gardner, Massachusetts.

HENSON, EDWARD B., September, 1910.
Distribution Foreman, Gas Plant, San Antonio Gas & Electric Company, 504 Goliad Street, San Antonio, Texas.

HILL, DANIEL L., March, 1911.
Superintendent of Records, Toronto Gas Company, 19 Toronto Street, Toronto, Canada.

HOFF, JOHN F., March, 1913.
Superintendent, Public Service Gas Company, 45 Witherspoon Street, Princeton, New Jersey.

HOFFMAN, ARMIN STANDISH, March, 1914.
Mechanical Engineer, B. P. Clapp Ammonia Company, 27th Street, between G and H Streets, N. W., Washington, District of Columbia.

HOWARD, CHARLES O. S., September, 1912.
Hartford City Gas Light Company, 60 Front Street, Hartford, Connecticut.

HUMPHREYS, RUSSELL GARRETSON, March, 1914.
Assistant in Engineering Department, Lawrence Gas Company, 370 Essex Street, Lawrence, Massachusetts.

HUNT, HAROLD WILLIAM, September, 1914.
Apprentice, Detroit City Gas Company, Station A, Detroit, Michigan.

HYLAND, HARRY B., March, 1914.
Assistant Superintendent, Consolidated Gas Company, 66th Street and West End Avenue, New York, New York.

INNES, J. A., October, 1906.
Secretary and Treasurer, Citizens Light, Heat & Power Company, Eagle Grove, Iowa.

JONES, CHARLES C., March, 1914.
Assistant Superintendent, West Philadelphia District, Philadelphia Gas Works, The United Gas Improvement Company, 3334 North 21st Street, Philadelphia, Pennsylvania.

JONES, DWIGHT WILLIAMS, September, 1915. (P)
Cadet Engineer, Pacific Gas & Electric Company, 2031 Vallejo Street, San Francisco, California.

JONES, LEON B., September, 1912. (P)
Assistant Engineer, Gas Department, Pacific Gas & Electric Company, Foot Humboldt Street, San Francisco, California.

Kane, Milford L., September, 1911.
General Manager, Brandon Gas & Power Company, Ltd., Brandon, Manitoba, Canada.

Kawai, Hideichi, September, 1912.
Engineer, Ichigi, Takahashinuna Nishikamogun, Mikawa, Japan.

Keeler, Earl E., March, 1912.
General Shop Foreman, Kansas City Gas Company, 910 Grand Avenue, Kansas City, Missouri.

Kellogg, Harrison B., September, 1909.
Engineer, Westchester Lighting Company, 22 Cottage Place, Tarrytown, New York.

Killgore, James N., March, 1913.
Assistant Superintendent of Distribution, Public Service Gas Company, 35 Front Street, Newark, New Jersey.

Kingsbury, I. Clayton, March, 1909.
Assistant Superintendent, Mains and Services, Consolidated Gas Company of New York, 134 East 15th Street, New York, New York.

Klar, Robert Lyle, March, 1914.
Power Plant Engineer, Philadelphia Gas Works, 5524 Chew Street, Germantown, Philadelphia, Pennsylvania.

Knauss, Douglas Stanley, March, 1914.
Cadet Engineer, Philadelphia Gas Works, 5861 Hadfield Street, Philadelphia, Pennsylvania.

Knothe, W. J., October, 1906.
Salesman, Gas Bench Department, Missouri Fire Brick Company, 411 Olive Street, St. Louis, Missouri.

Kollock, Edward Campbell, March, 1913.
Superintendent, Gas Department, Charleston Consolidated Railway & Lighting Company, 141 Meeting Street, Charleston, South Carolina.

Kruger, Paul, September, 1914.
Prepayment Bookkeeper, Westchester Lighting Company, 558 East 191st Street, New York, New York.

Lafore, Paul Jules, September, 1909.
With Surface Combustion Company, 150 West 52nd Street, New York, New York; 4746 Hazle Avenue, Philadelphia, Pennsylvania.

Lake, Morton, September, 1915.
Foreman, Gas Meter Shop, St. Paul Gas Light Company, 112 East Lawson Street, St. Paul, Minnesota.

Leuenberger, Walter Arnold, March, 1908. (P)
Superintendent, Tacoma Gas Company, 22d and Dock Streets, Tacoma, Washington.

LEVAN, DANIEL H., September, 1915.
Cadet Engineer, Omaha Gas Company, 1509 Howard Street, Omaha, Nebraska.

LOCKWOOD, ALAN E., September, 1915.
Manager, Gas Light Company, Suffolk, Virginia.

LOUD, ROGER PERKINS, March, 1912.
87 Commercial Street, Weymouth, Massachusetts.

MACSAVENY, ROBERT, JR., March, 1914.
Night Foreman, Brooklyn Union Gas Company, Foot North 12th Street, Brooklyn, New York.

MCCARTHY, ALBERT P., March, 1911.
Engineer, Philadelphia Suburban Gas & Electric Company, Coatesville, Pennsylvania.

MALAKOFF, JOHN, September, 1912.
General Foreman, Gas Works, Westchester Lighting Company, Spring Street, White Plains, New York.

MALIN, J. H., September, 1912.
Storekeeper, Omaha Gas Company, 1202 Howard Street, Omaha, Nebraska.

MALONEY, GEORGE JOSEPH, March, 1914.
Superintendent, Kennett Gas Company, Kennett Square, Pennsylvania.

MARSH, EDWARD H., September, 1913.
Shop Foreman, Queens Borough Gas & Electric Company, 347 Central Avenue, Far Rockaway, New York.

MAYFIELD, PAUL C., March, 1914.
Assistant Superintendent, Philadelphia Gas Works, The United Gas Improvement Company, 3253 North 16th Street, Philadelphia, Pennsylvania.

MILLER, MISS ANNA VIRGINIA, October, 1906.
Demonstration Cooking Lecturer, 1237 Harrison Street, Kansas City, Missouri.

MINARD, EMORY D., September, 1913.
General Foreman, Public Service Gas Company, 118 Main Street, Hackensack, New Jersey.

MITCHELL, HERMAN W., March, 1914.
Cashier and Office Manager, Rome Gas, Electric Light & Power Company, 139 North James Street, Rome, New York.

MITCHELL, WYLIE, March, 1914.
Superintendent Distribution, St. Joseph Gas Company, 802 Francis Street, St. Joseph, Missouri.

MORRISON, MARTIN, September, 1912.
Candle-Power Inspector and Cadet Engineer, Westchester Lighting Company, 48 Robertson Avenue, White Plains, New York.

Moyer, Wayne R., September, 1913.
Assistant Superintendent, Spring Garden District, The United Gas Improvement Company, 446 West Martin Street, Roxborough, Philadelphia, Pennsylvania.

Mueller, Adolph F., March, 1910.
Head Bookkeeper, Seattle Lighting Company, Seattle, Washington.

Muller, Herman, Jr., September, 1908.
Works Assistant, New York & Richmond Gas Company, 691 Bay Street, Stapleton, Staten Island, New York.

Murphy, Albert Francis, September, 1912.
Assistant to Superintendent, Brooklyn Union Gas Company, 176 Remsen Street, Brooklyn, New York.

Murphy, Harold Purves, March, 1914.
Cadet Engineer, The United Gas Improvement Company, 116 West Penn Street, Germantown, Philadelphia, Pennsylvania.

Nason, Forest J., September, 1913.
Clerk, Blackstone Valley Gas & Electric Company, Woonsocket, Rhode Island.

Neal, George A., September, 1912.
Engineer's Assistant, Northern Indiana Gas & Electric Company, Hammond, Indiana.

Nelson, E. A., March, 1909.
Engineering Assistant of Mains and Services, Consolidated Gas Company of New York, 80 Elizabeth Street, New York, New York.

Nelson, William Harris, March, 1914.
Cadet Engineer, St. Paul Gas Light Company, 6th and Jackson Streets, St. Paul, Minnesota.

Neth, John A., October, 1906.
Foreman, Gas Department, Westchester Lighting Company, 14 Archer Park, Tarrytown, New York.

Nissley, Warren W., September, 1914.
New Business Manager, Nassau & Suffolk Lighting Company, Hempstead, Long Island, New York.

O'Keeffe, James Garwood, March, 1908.
Market Street Works, Public Service Gas Company, Newark, New Jersey.

Osborn, Norris Whitlock, March, 1915. (P)
Gas Engineer, Pacific Gas & Elecric Company, San Jose, California.

Palmer, Alva L., September, 1913.
Engineer's Assistant, Department of Utilization, Consolidated Gas Company of New York, 130 East 15th Street, New York, New York.

Patterson, Clement F., September, 1911.
Whittier, California.

Pearce, William Faulkner, March, 1908.
Montreal, Canada.

Peden, H. L., March, 1909.
Assistant Superintendent, Distribution Department, Consolidated Gas Company of New York, 130 East 15th Street, New York, New York.

Perkins, Matthew F., September, 1909.
Chief Canvasser, The United Gas Improvement Company, 5813 Thompson Street, Philadelphia, Pennsylvania.

Pfeiffer, Bernard V., September, 1911.
Engineer, Nashville Gas & Heating Company, 722 Second Avenue, North, Nashville, Tennessee.

Platt, Louis Julius, September, 1914.
Industrial Fuel Representative, Public Service Gas Company, 909 Park Avenue, Hoboken, New Jersey.

Postles, John V., September, 1913.
Cadet Engineer, 115 South 22d Street, Philadelphia, Pennsylvania.

Price, William H., October, 1906.
Draftsman and Clerk, Providence Gas Company, 93 Georgia Avenue, Providence, Rhode Island.

Pugh, Frank S., September, 1914.
Foreman of Mains and Services, Porto Rico Gas Company, Fernland Farm, Rio Piedras, Porto Rico.

Rasch, Wm. T., March, 1909. (P)
Assistant to Engineer of Utilization, Consolidated Gas Company of New York, 130 East 15th Street, New York, New York.

Reading, Harry Bruce, September, 1915.
Laboratory Assistant, Brooklyn Union Gas Company, Nevins and DeGraw Streets, Brooklyn, New York.

Reiley, Frederick Asbury, March, 1914.
Engineering Assistant, Waterbury Gas Light Company, Waterbury, Connecticut.

Reiner, Otto, September, 1912.
General Foreman, Public Service Gas Company, 41 Front Street, Newark, New Jersey.

Reynolds, James Fisher, September, 1913.
Industrial Salesman, Consolidated Gas Company, 130 East 15th Street, New York, New York.

Rhoads, William Henry, September, 1913.
Engineer's Assistant, Consolidated Gas Company, 130 East 15th Street, New York, New York.

Richardson, R. B., September, 1914.
Works Superintendent, Decatur Railway & Light Company, Decatur, Illinois.

Riordan, Daniel, March, 1913.
Chief Clerk in Works Office, Consolidated Gas Company, 501 East 21st Street, New York, New York.

Ritchie, Arthur Robson, March, 1911.
Superintendent, Consolidated Gas Company, 14th Street and Avenue C, New York, New York.

Roberson, Jay C., March, 1913.
Superintendent of Distribution, Public Service Gas Company, Peace and Washington Streets, New Brunswick, New Jersey.

Robinson, Chauncey D., September, 1911.
Sales Representative, Diamond Rubber Company, Broad and Spring Garden Streets, Philadelphia, Pennsylvania.

Root, William A., March, 1915.
Commercial Manager, Bronx Gas & Electric Company, 2358 Lyon Avenue, Bronx, New York, New York.

Russell, James, September, 1913.
Assistant Chief Draughtsman, The United Gas Improvement Company, 3141 North 17th Street, Philadelphia, Pennsylvania.

Schell, William F., March, 1913.
Philadelphia Company, 435 Sixth Avenue, Pittsburgh, Pennsylvania.

Schlegel, Carl A., September, 1913.
Engineer of Construction, Northern Indiana Gas & Electric Company, South Bend, Indiana.

Schroeder, Carl Robert, March, 1912.
Cadet Engineer, Distribution Department, Public Service Gas Company, 1045 Bloomfield Street, Hoboken, New Jersey.

Schuck, Conrad, Jr., March, 1911.
Assistant Superintendent, Public Service Gas Company, 258 North Park Street, East Orange, New Jersey.

Scott, William Doke, March, 1914.
Engineering Assistant, Syracuse Lighting Company, Syracuse, New York.

Seeley, Harold K., September, 1913.
Assistant Superintendent, City District, The United Gas Improvement Company, 1931 South 9th Street, Philadelphia, Pennsylvania.

SHAUGHNESSY, THOMAS, JR., September, 1912.
Engineer's Assistant, Consolidated Gas Company, 130 East 15th Street, New York, New York.

SHEEHY, JOHN CHARLES, September, 1911.
Distribution Foreman, Queens Borough Gas & Electric Company, 347 Central Avenue, Far Rockaway, New York.

SHERWOOD, HERBERT, September, 1910.
Superintendent, Westchester Lighting Company, 119 Woodworth Avenue, Yonkers, New York.

SMITH, GEORGE HOWARD, March, 1914.
Assistant District Superintendent, Central Hudson Gas & Electric Company, 129 Broadway, Newburgh, New York.

SMITH, GEORGE LATHROP, September, 1913.
With Des Moines Gas Company, 412 West 7th Street, Des Moines, Iowa.

SMITH, OLIVER HOBSON, September, 1914.
Assistant Superintendent, New Amsterdam Gas Company, Ravenswood Works, Long Island City, New York.

SOMMAR, ALBAN M., March, 1913.
Chief Clerk, Omaha Gas Company, 1509 Howard Street, Omaha, Nebraska.

SPRAU, ROBERT LEE, September, 1912.
Assistant Superintendent, Louisville Gas & Electric Company, 1108 Logan Street, Louisville, Kentucky.

STEERE, FRANK W., September, 1914.
Vice-President and Chief Engineer, Steere Engineering Company, Woodward and Horton Avenues, Detroit, Michigan.

STRADER, ROLAND HOWARD, March, 1915.
Junior Assistant to Superintendent, Standard Gas Light Company, 710 Chauncey Street, Brooklyn, New York.

STURDEVANT, WALTER, September, 1914.
Assistant in General Superintendent's Department, The United Gas Improvement Company, 4530 Regent Street, Philadelphia, Pennsylvania.

TABER, WILLIAM B., JR., September, 1915.
Care of The Aetna Explosives Company, 2 Rector Street, New York, New York.

TARRANT, STANLEY G., March, 1912.
Statistician, Westchester Lighting Company, 1st Avenue and 1st Street, Mount Vernon, New York.

TAYLOR, PERCIVAL DRAYTON, March, 1914.
Engineer, The United Gas Improvement Company, 1401 Arch Street, Philadelphia, Pennsylvania.

Tenney, George C., March, 1912.
Mechanical Engineer, Public Service Gas Company, 33 Prospect Street, Elizabeth, New Jersey.

Tinney, Thomas Brown, March, 1913.
Chemist, The United Gas Improvement Company, 303 Lafayette Avenue, Collingdale, Pennsylvania.

Tobias, William A., September, 1912.
Porto Rico Gas Company, San Juan, Fernland Farm, Rio Piedras, Porto Rico.

Torrey, Bates, Jr., March, 1915.
Cadet Engineer, Semet-Solvay Company, Solvay Club House, Syracuse, New York.

Tour, Reuben S., March, 1912. (P)
Assistant Professor of Gas Engineering, University of California, Mechanics Building, Berkeley, California.

Tozier, George E., September, 1914.
Distribution Foreman, Henrico County Gas Company, 900 North Avenue, Barton Heights, Richmond, Virginia.

Travis, George W. **Leroy**, September, 1912.
Assistant Engineer, Department Mains and Services, Consolidated Gas Company, 130 East 15th Street, New York, New York.

Van Vliet, Rutherford, September, 1914.
Apprentice, Detroit City Gas Company, Station B, Detroit, Michigan.

Vecker, Samuel P., March, 1912.
Manager, Key West Gas Company, Fleming and Simonton Streets, Key West, Florida.

Vredenburgh, Frank W., September, 1915.
Supervisor of Gas Distribution, Central Hudson Gas & Electric Company, 128 Broadway, Newburgh, New York.

Warner, Charles Pierie, March, 1910.
Cadet Engineer, Allentown-Bethlehem Gas Company, Allentown, Pennsylvania.

Welsh, M. G., September, 1915.
Engineer, Mohawk Gas Company, 17 Springfield Avenue, Schenectady, New York.

Wellwood, Arthur R., March, 1914.
Assistant District Superintendent, Central Hudson Gas & Electric Company, 50 Market Street, Poughkeepsie, New York.

Whipple, Robert H., March, 1913.
Engineering Department, American Gas Company, West Washington Square, Philadelphia, Pennsylvania.

WHITE, ALBERT RAY, March, 1915.
With Menominee & Marionette Light & Traction Company, Menominee, Michigan.

WHITE, WILLIAM MORSE, March, 1912.
Superintendent, Coke Oven Department, Philadelphia Suburban Gas & Electric Company, 2503 West Fourth Street, Chester, Pennsylvania.

WILLIAMSON, JOHN A., March, 1914.
Assistant Superintendent of Construction, Peoples Gas Light & Coke Company, Peoples Gas Building, Chicago, Illinois.

WILSON, CHARLES JAMES, March, 1914.
Salesman, with St. Clair County Gas & Electric Company, Belleville, Illinois.

WILSON, WARD, October, 1906.
Foreman of Distribution, Lynchburg Traction & Light Company, 316 Euclid Avenue, Lynchburg, Virginia.

WIMBERLY, ALBERT HOMER, September, 1914.
Foreman, Distribution Shop, Atlanta Gas Light Company, Electric and Gas Building, Atlanta, Georgia.

WISKE, PRESCOTT B., March, 1913.
Superintendent's Assistant, Brooklyn Union Gas Company, 5th and Hoyt Streets, Brooklyn, New York.

WOOD, FRANK A., September, 1912.
7 Florida Street, Dorchester, Massachusetts.

WRIGHT, WILLIAM GANO, September, 1912.
Street Clerk, Westchester Lighting Company, 119 Woodworth Avenue, Yonkers, New York.

ZANE, ALLEN HERBERT, March, 1914. (P)
Superintendent's Assistant, Astoria Light, Heat & Power Company, Astoria, Long Island, New York.

ZOOK, SAMUEL KURTZ, October, 1906.
Superintendent, Public Service Gas Company, Washing and Peace Streets, New Brunswick, New Jersey.

Total Junior Members 190

SUMMARY.

Honorary	4
Life	2
Active	1,111
Associate	218
Junior	190
Total	1,525

SECTIONAL REGISTRATION

Letter following the name designates the Section in which the member is registered.

A—Accounting Section.
C—Chemical Section.
D—Distribution Section.
I—Illumination Section.
M—Manufacturing Section.

CONSTITUTION—SECTION 39. " * * * Any member of the Institute may attend the meeting of any section at any time. Any Honorary, Active, Associate or Junior member in good standing may vote on the election of section officers or on other matters connected with section organization in one section only, and to so vote must register as a voting member of such section. * * * "

BY-LAW 24 (SECTION 39). "The voting lists for section matters shall be drawn up from the list of members as published in the last volume of the PROCEEDINGS, in which the section registration of each member shall be shown."

MEMBERS OF THE AMERICAN GAS INSTITUTE ARRANGED GEOGRAPHICALLY

ALABAMA

Birmingham

A. H. Ford.
J. E. Montgomery. (D)

Mobile

Albert F. Kersting. (M)

Montgomery

B. C. Adams.
R. John Titzel

Selma

R. L. Ellis.

Woodward

John Drewson.

ARKANSAS

Little Rock

W. F. Booth.

CALIFORNIA

Berkeley

Reuben S. Tour. (M)

Colusa

L. H. Hartsock.

Jackson

B. E. Letang.

Los Angeles

Robert M. Adams. (I)
F. R. Bain.
William Baurhyte. (D)
Jos. M. Berkley.
Henry W. Burkhart.
Frank Cavenagh
W. B. Cline. (D)
John T. Creighton. (M)
Addison B. Day. (C)
William J. Dorr. (D)
Robt. F. Fitz.
J. D. Hackstaff.
Charles P. Houghton. (M)
Charles A. Luckenbach. (I)
A. B. Macbeth. (D)
Thomas P. McCrea. (A)
F. C. Millard. (D)
C. S. Vance. (A)

Modesto

Frank A. Cressey, Jr.

Oakland

F. A. Leach, Jr. (D)

Pasadena

C. W. Koiner. (D)

Sacramento

E. S. Jones. (M)

San Diego

Henry H. Jones.

San Francisco

C. B. Babcock
John A. Britton.
J. A. Britton, Jr. (M)
V. E. Britton. (M)
F. G. Drum.
Sherwood Grover. (D)
W. M. Henderson. (D)
A. F. Hockenbeamer.
D. W. Jones. (M)
Edward C. Jones. (M)
Leon B. Jones. (M)
D. E. Keppelmann. (D)
John Martin.
C. O. G. Miller. (A)

CALIFORNIA—*Continued*

San Francisco

Saml. L. Naphtaly.
J. B. Redd
R. J. Thompson. (I)

San Jose

Robert H. Hargreaves. (M)
John D. Kuster.
N. W. Osborn. (C)

Santa Monica

W. H. Bettle.
W. S. Dole. (M)

San Rafael

A. J. Rix. (M)

Upland

Isaac C. Baxter. (M)

Whittier

C. F. Patterson.

COLORADO

Denver

M. E. Malone. (D)
Clare N. Stannard. (I)
A. F. Traver. (M)

Pueblo

James M. Dailey.
C. C. Durkee.

CONNECTICUT

Bridgeport

C. M. Gerdenier. (M)
Wm. P. Hutchinson. (D)
Ralph I. Munson. (A)
A. J. Palmer. (M)
Geo. W. Roberts.
H. H. Sprague.

Danbury

G. E. Cowperthwaite. (M)

Derby

Chas. H. Nettleton. (M)
George H. Scranton.

Hartford

P. R. Buchanan.
C. O. S. Howard.
B. W. Perkins. (M)

Meriden

Charles A, Learned. (M)

Middletown

Edgar C. Weston. (M)

Milford

William Reeves.

New Haven

Philmer Eves.
N. H. Gellert. (C)
J. Arnold Norcross. (M)
T. R. Sucher. (D)
C. E. Thompson.
Howard E. White. (M)
Robert E. Wyant. (M)

New London

V. E. Bird.

Stamford

Henry J. Warren. (M)
John A. Waters.

Stepney Depot

F. B. Wheeler.

Thompson

C. L. Gerould. (M)

Thompsonville

W. P. Schwabe. (D)

Torrington

Frank M. Travis.

Waterbury

Alex. J. Campbell. (D)
F. A. Reiley. (D)
E. H. Williams.

DELAWARE

Wilmington

Wm. J. McCorkindale. (D)

DISTRICT OF COLUMBIA

Washington

C. Clay Bayly.
Frederic Egner.
A. S. Hoffman. (M)
Thomas F. Holden.
James S. McIlhenny.
Robert L. Middleton.
Howard Reeside.
C. E. Reinicker. (D)
T. Symmes Tincher.
Sanford N. Whitwell. (A)

FLORIDA

Jacksonville

C. S. Hammatt. (D, I, M)
T. C. Gibbs.
Harry B. Hoyt.
David S. Long. (M)

Key West

S. P. Vecker.

Pensacola

Charles F. Zeek. (M)

St. Augustine

Daniel Fitzpatrick. (M)
C. L. Lyon.

St. Petersburg

F. B. Crowell

Tampa

LeRoy C. Heavner.
Rosco Nettles.

GEORGIA

Atlanta

P. S. Arkwright.
R. C. Congdon.
C. J. Weinmeister. (D)
A. D. Whittaker. (M)
A. H. Wimberly.

Augusta

F. L. Marshall. (D)
Morris D. Schindler.

Columbus

MacDougald Dexter.

Macon

George R. Horning. (M)

Rome

James Ferrier.

Savannah

J. L. Cabell. (M)
C. F. Carter.
John W. Golden. (D)
J. C. Grey.

ILLINOIS

Aurora

I. C. Copley. (M)
F. M. James.
P. O'Malley.
Carroll Miller. (M)
R. N. Strohn.

Belleville

H. B. Kircher. (M)
C. J. Wilson

Chicago

Knowlton L. Ames.
C. F. Asendorf. (M)
Wm. A. Baehr. (M)
T. R. Beebe.
R. W. Bingham. (I)
Chas. W. Bradley.
D. H. Brush, Jr.
F. S. Carnes.
Alfred A. Chichester.
H. H. Clark. (D)
R. K. Clark.
Mathias Connors. (M)
Edward G. Cowdery.
G. H. Cressler.
James E. Davies. (D)
R. N. Davis.
H. M. Dawes.
Rufus C. Dawes.
C. L. Day.
Alfred B. Eaton. (M)
L. B. Elliott. (D)
I. C. Elston, Jr.

ILLINOIS—*Continued*

Chicago

Ralph Esau.
John H. Eustace. (M)
J. F. Gilchrist.
John Ginley.
H. D. Harper.
R. B. Harper. (C)
Julian G. Hart. (M)
W. E. Hartman.
Homer T. Hirst, Jr.
Jesse B. Hirst. (D)
H. R. Hunt.
William B. Jackson.
Benjamin J. Kellum.
Wm. J. Knapp.
F. A. Lathrop.
J. W. Lawlor. (M)
Henry I. Lea.
Thomas J. Lucas. (M)
A. J. Luick. (M)
F. E. Luther. (M)
J. N. McCallum.
N. A. McClary.
F. G. Manly. (M)
Joseph C. Markley.
William P. Martin.
Charles W. Melcher. (D)
T. D. Miller. (M)
Thomas N. Mordue.
John M. Morehead. (C)
Edward E. Morrell.
Wm. J. Norton. (A)
H. L. Olds. (M)
George G. Olmsted.
Otto E. Osthoff.
F. E. Park. (C)
D. W. Penington.
L. R. Phillips.
Edward G. Pratt. (M)
Theo. V. Purcell.
James A. Rafferty. (M)
Richard Rees. (A)
S. A. Reinhard. (M)
Irwin Rew.
Daniel Roesch.
Rudolph Schenck. (M)
C. C. Schiller.
Samuel C. Shaffner.
Jacob M. Spitzglass. (M)
W. D. Sweetman.
J. S. Unger.
Lyman A. Wiley. (D)
J. A. Williamson. (M)
John Williamson.
Herman Zitzewitz.

Decatur

Robert Mueller. (D)
R. B. Richardson. (M)

Dixon

Edward W. Galloway.
Justin E. Harlow.

East St. Louis

Charles H. Quackenbush. (M)

Elgin

C. B. Strohn.

Evanston

Andrew McIntyre. (M)

Freeport

E. D. V. Dickey.

Galesburg

B. H. Danforth.

Joliet

A. D. Cressler.
A. M. Cressler.
A. H. Harris, Jr. (M)
H. J. Mitchell.

Kankakee

F. E. Newberry. (M)

Kewanee

Elmer W. Smith.

Mendota

E. W. Galloway. (M)

ILLINOIS—*Continued*

Oak Park

Mathias Britsch.

Peoria

H. E. Chubbuck.
Ross S. Wallace.

Quincy

Harry O. Channon. (M)
Charles McDonnell. (M)

Rockford

C. W. Butterworth.
A. W. Kendall.
Garnet W. McKee.
J. F. Parker. (M)
Roland G. Porter. (M)
George D. Roper. (M)
Henry S. Whipple. (A)
W. A. Wilson.

Rock Island

D. G. Porter.

South Chicago

W. H. Allen, Jr. (M)

Springfield

A. S. B. Little.
C. H. Lanphier.

Waukegan

George F. Goodnow. (M)

INDIANA

Anderson

M. G. Reynolds.

Columbus

C. M. Keller.

Connersville

George C. Hicks, Jr. (M)
E. D. Johnston. (M)
J. S. Tatman.

Evansville

J. C. Silverthorn.

Fort Wayne

Fred W. Freese.
Olaf N. Guldlin.
G. Max Hofmann.
Lothar Hofmann.
S. E. Mulholland. (D)
Thomas W. Stone.
Orrell O. Thwing.
John V. Wills.

Gary

Leonard Fitzgerald. (M)

Greencastle

John G. Martin.

Hammond

H. W. Duncan.
H. C. Miller. (A)
G. A. Neal. (D, M)
B. S. Walters. (M)

Indianapolis

H. M. Chapman. (M)
S. T. Murdock.
Frank W. Sargeant. (D)
George Summers. (D, M)
W. H. Wright. (M)

Jeffersonville

Frank Huber. (D, I, M)

Marion

D. S. Milne.

Muncie

J. E. Colvin.
J. H. Maxon. (D)

New Albany

James W. Dunbar. (M)

Noblesville

R. H. Lawlor.

INDIANA—*Continued*

Princeton

Harry Firstbrook.

South Bend

H. V. Armstrong.
C. N. Chubb. (M)
C. A. Schlegel.

Terre Haute

C. D. Shaul. (M)

Valparaiso

LeRoy O. Gordon. (M)

IOWA

Boone

H. G. Stillson. (M)

Burlington

Edward D. Clary.

Cedar Rapids

H. J. Carson.
Thomas Suchomel.

Charles City

S. G. Smith. (M)
R. K. Runner.

Clinton

Thomas Crawford.

Council Bluffs

A. L. English.

Davenport

Hubert C. Blackwell.
D. G. Fisher.
Ernest Jacobson.
Joseph F. Porter. (A)

Des Moines

T. Bertram Genay. (M)
Jansen Haines.
E. H. Martin. (I)
Emil G. Schmidt.
G. L. Smith. (D)
W. H. Thomson, Jr.
G. I. Vincent. (M)

Dubuque

George McLean.
Edwin M. Walker. (M)

Eagle Grove

J. A. Innes.

Fort Dodge

R. M. Parker.

Muscatine

F. S. Dewey.

Oskaloosa

A. H. R. Jackson.

Sioux City

Wm. J. Bertke.
Leonard L. Kellogg. (M)

Washington

George S. Carson.

Waterloo

Austin Burt. (D)
H. M. Smith.

Webster City

Campbell W. Fair. (A)

KANSAS

Chetopa

James C. Gibson.

Kansas City

W. H. McKenzie.
C. H. Waring. (D)

Topeka

George J. Swan. (D, M)
L. G. Treleaven. (A)

KENTUCKY

Louisville

A. H. Barret.
William H. Crutcher.
Geo. H. Harries.
Donald McDonald.
Robt. L. Sprau.
Harry R. Swann. (D)

Paducah

Fred Cloen. (M)

Richmond

Benj. A. Dougherty.

LOUISIANA

Hammond

F. W. Reimers.

New Orleans

Geo. H. Davis.
H. M. Harriman.
Wm. vonPhul.

MAINE

Augusta

Walter S. Wyman.

Bangor

Herbert E. Harriman.
O. A. Merchant, Jr. (M)

Biddeford

Saml. L. Parcher.

Harpswell

E. E. Witherby. (M)

Lewiston

John J. Scott.

Portland

Fred N. Dow.
C. O. Pratt. (M)
Burton Smart.

Waterville

L. L. Cadwallader.

MARYLAND

Baltimore

George R. Althen. (D)
George Beadenkopf. (M)
Howard Bruce.
C. H. Claiborne.
Charles M. Cohn.
Charles H. Dickey.
Edmund S. Dickey.
E. Bartlett Hayward.
E. S. Newbold.
George P. Marrow.
W. R. Moulton. (I)
L. Irving Pollitt.
Louis N. Rancke.
Edward L. Rieha. (M)
H. M. Riley. (D)
Albert Rosenthal. (D, M)
R. S. Scott.
Carl C. Thomas. (D)
Fred H. Wagner.

Sparrows Point

L. B. Robertson. (M)

MASSACHUSETTS

Attleboro

William J. Luther.

Beverly

C. R. Prichard. (M)

Boston

Perry Barker. (C)
W. B. Calkins.
Herbert N. Cheney.
Alfred Clarke.
F. N. Eisenman.
John A. Gould. (D)
Robert Grant.
Chas. W. Hunter. (M)
D. C. Jackson.
Wm. J. Lavelle. (D)
A. D. Little.
W. E. McKay. (M)
D. E. Manson.
Arthur E. Norton. (D)
Harry A. Norton.
Edward Page.
Alfred R. Patterson. (A)
Theo. H. Piser.
J. L. Richards.
Frederick P. Royce.
Howard T. Sands.
Albert B. Tenney.
Bowen Tufts.
Hans von Vittinghoff. (C, M)
P. B. Webber.
F. K. Wells.
William Austin Wood. (M)
Edgar N. Wrightington.

MASSACHUSETTS—*Continued*

Brockton

J. S. String. (M)

Cambridge

Albert M. Barnes. (D)

Charlestown

S. J. Fowler. (A, C, D, I, M)

Dorchester

F. A. Wood.

East Boston

N. W. Gifford.

East Braintree

Geo. P. Smith, Jr. (D)

East Cambridge

Isaac T. Haddock.
J. P. Kennedy.

Everett

Howell Fisher.
Robert M. Folsom.
J. M. McClellon.
Alexander B. Way.
John F. Wing. (M)

Fall River

R. Buckminster. (M)
R. B. Clark. (M)
E. R. Hamilton. (C)
Joseph E. Nute. (M)

Fitchburg

Clifton R. Hayes.
George W. Stiles. (M)

Framingham

George H. Priest. (M)

Gardner

Hiram Helman.

Haverhill

Charles Otten, Jr. (M)
F. M. Roberts. (M)

Holyoke

O. W. Adams. (M)

Lawrence

C. J. R. Humphreys. (M)
R. G. Humphreys. (M)
W. M. McQueston. (M)
Fred H. Sargent.
H. G. Taylor. (M)

Lowell

W. H. Hinman.
W. B. Osborne.

Lynn

F. E. Drake. (M)
H. K. Morrison. (M)

Malden

C. E. Paige.

New Bedford

Robert Lindsay.
Wm. H. Snow. (M)

Newton

Waldo A. Learned.

North Woburn

J. E. Philbrick.

Pittsfield

Harry C. Crafts. (M)

Quincy

Wm. B. Nichols. (D)

Roxbury

F. F. Tripp. (I)

Salem

J. L. Tudbury.

Springfield

Benjamin P. Bill.
Wallace H. Bradley.
Herman Burgi. (M)
Charles H. Tenney.

Webster

H. S. Shaw.

Weymouth

R. P. Loud. (D)

Winchester

Chas. W. Hinman. (C)

Worcester

Dana D. Barnum. (M)

MICHIGAN

Ann Arbor

Henry W. Douglas. (M)
Alfred H. White. (C)

MICHIGAN—*Continued*

Battle Creek

F. K. Berry.
D. H. Frazer.

Bay City

Samuel Ball. (M)

Benton Harbour

Edward Olsen. (M)

Big Rapids

R. Shacklette. (M)

Detroit

Abram T. Baldwin.
William T. Barbour.
J. W. Batten. (M)
Warren S. Blauvelt. (M)
Dwight F. Burritt.
J. E. Collins.
F. G. Curfman
V. F. Dewey.
H. M. Eaton.
Alonzo P. Ewing.
R. A. Field. (D)
Wm. S. Guitteau. (D, M)
Wm. G. Henry. (M)
H. W. Hunt.
Ralph A. Jayne.
E. H. Jewett.
George I. Keal. (M)
Nathan G. Leakey. (M)
Alfred G. Lloyd.
Ernest F. Lloyd.
James T. Lynn.
George Osius. (C)
Charles S. Ritter.
Henry D. Schall. (D)
C. A. Schwarm. (D)
A. F. Shattuck. (C)
Otis A. Sinsel. (M)
F. W. Steere. (C)
B. O. Tippy.
A. A. Treadway. (D)
R. Van Vliet.
Edwin G. Van Wie.
A. L. Wilkinson.
Leigh E. Worthing. (C)
L. B. Young. (M)

Grand Rapids

Jos. H. Brewer.
G. R. Chamberlain.
S. W. Cheney.
John Hellen.
Frank T. Hulswit. (A)
Jno. A. Hulswit. (A)
Chas. B. Kelsey.
Richard Schaddelee.
Albert G. Schroeder. (A)
Frederick W. Seymour. (M)
Albert I. Snyder.
T. J. Weber.
John T. Young.

Jackson

Jas. A. Brown.
W. M. Eaton.
B. R. Laraway.
C. W. Tippy.

Kalamazoo

Frank W. Blowers.
Charles T. Chisholm.
J. J. Knight. (D)

Marquette

H. J. Waterbury. (D)

Marshall

Carroll Collins. (M)

Menominee

Albert R. White.

Muskegon

J. J. Humphreys.
Wm. M. Lewis.

Port Huron

J. C. Sloan. (M)

Sault Ste Marie

James Trimble. (C)

MINNESOTA

Crookston

H. M. Moore.

Duluth

C. W. Andrews.
David Elder.

MINNESOTA—*Continued*

Faribault

B. W. Cowperthwait.

Mankato

Robert E. Brown.

Minneapolis

A. E. Call. (M)
Frederick C. Shepard. (M)

St. Paul

John P. Crowley. (A)
Paul Doty. (A)
D. W. Flowers. (M)
Ole S. Johnson. (D)
Morton Lake. (D)
E. L. Lambert. (D)
W. H. Nelson. (M)
Bert. F. Pelton. (D)
George Steinwedell.
H. B. Stiles.

Winona

Wm. F. Clausen.

MISSISSIPPI

Jackson

Raymond H. Smith.

Vicksburg

John J. Gannon. (D)

MISSOURI

Boonville

W. E. Sombart.

Chillicothe

C. M. Willis. (M)

Excelsior Springs

Saml. W. Henderson.

Independence

Robert S. Miller. (M)

Joplin

B. J. Crahan.

Kansas City

E. L. Brundrett.
E. W. Hammond.
A. Hurlburt. (D)
E. E. Keeler.
Miss Anna Virginia Miller
F. F. Schauer. (D)
John M. Scott. (A)
M. M. Sweetman.

Sedalia

H. D. Frueauff.

St. Charles

Lee G. Stealey.

St. Joseph

V. L. Elbert. (M)
Wylie Mitchell.

St. Louis

J. J. Burns. (I)
Augustin J. Daly.
John Dell. (M)
A. C. Einstein.
Geo. B. Evans. (C, M)
R. D. Hatton.
C. L. Holman.
W. J. Knothe.
W. A. Lockwood.
Donald MacArthur. (M)
G. W. Parker.
Jesse E. Pipkin.
Barney H. Sanders. (M)
Robert Seeger.
C. H. Stewart.
Jacob D. von Maur.
H. C. Wehnert. (M)
W. H. Whitton.
Leigh Wickham.

Webster Groves

J. E. Hillemeyer. (D)
S. H. Wallace.

MONTANA

Billings

Ira C. Covert. (M)

Bozeman

Arthur W. Richter.

Missoula

Edward C. Collier. (D)

NEBRASKA

Fremont

W. H. Merritt.

Hastings

A. W. Borden.

Omaha

G. W. Clabaugh.
Alfred H. Hansen.
D. H. Levan.
Joseph Lucena. (D)
J. H. Malin.
A. M. Sommar. (A)
Wm. H. Taylor. (M)

NEW HAMPSHIRE

Concord

A. J. Smith. (M)

Keene

G. M. Rossman.

Manchester

Walter G. Africa. (M)
Alex. H. Scott. (M)

Nashua

Walter F. Norton. (M)

NEW JERSEY

Atlantic City

Carlton Geist.

Atlantic Highlands

R. H. Garrison.

Bayonne

K. G. Mackenzie. (M)

Belmar

Joseph Mayer.

Bridgeton

J. B. Jones. (M)

Burlington

Edward Hering. (M)

Camden

John J. Burleigh.
George W. Curtis.
James N. Downey.
Harry Ellis. (D)
George Hobdell.
E. F. Miller.
E. A. Moore.
J. A. Riggins.
Wm. J. Rodgers. (D)

Dover

Seth H. Ely.

East Orange

Conrad Schuck, Jr. (D)

Elizabeth

Roger Crilley. (M)
Francis Engel. (D)
G. C. Tenney. (D)

Glassboro

Charles W. Hoy.

Gloucester City

F. G. Corbus.
F. N. Hamerstrom. (I)
Thomas J. Litle, Jr.
Sidney Mason.
Wm. P. McCoy.
Townsend Stites.
C. W. Wardell. (M)

Hackensack

Emory D. Minard. (D)
E. C. Roberts. (A)

Hoboken

John Cabot.
Albert F. Ganz.
L. J. Platt. (D)
R. C. Lewis
C. R. Schroeder.

Jersey City

James Ashworth.
West Bissell.
David R. Daly.
E. J. Donahue. (D)
J. P. Henofer.
F. W. Schmidt.

Long Branch

F. R. M. Cutcheon. (M)
L. E. DeQuine. (D)

Maurer

Daniel Miller. (C)

Morristown

Fredk. A. Lydecker. (D)

NEW JERSEY—*Continued*

Newark

Edward B. Annett. (D)
William S. Barker. (A)
William H. Chadwell.
John A. Clark, Jr.
J. S. De Hart.
E. H. Earnshaw. (M)
H. H. Ferris. (M)
A. J. Ford.
Ellsworth Francisco. (D)
H. D. Gillingham. (D, I)
W. M. Halsey. (A)
J. P. Hanlan.
James N. Killgore.
Thomas N. McCarter.
J. G. O'Keeffe.
W. H. Pettes. (A)
John P. Petty. (A)
O. F. Potter. (A)
Otto Reiner.
Geo. J. Roberts.
J. McClellan Rogers. (D, M)
Jas. R. Schurz.
Alexander H. Strecker.
Robert K. Wehner.
H. D. Whitcomb. (M)
Percy S. Young.
R. R. Young. (A, D, I)

New Brunswick

J. C. Roberson.
S. K. Zook.

Ocean City

A. H. Osborn.
Martin Maloney, 2d. (D)

Orange

H. G. Williams.

Passaic

Oliver H. Folger. (D)

Paterson

John Bimson, Jr.
Theo. Bunker.
Jas. M. Lane.
C. J. Roeser. (D)
W. H. Rogers. (A, D, I)
William L. Williams. (M)

Perth Amboy

Geo. A. Balz.
H. Foersterling. (C)
A. F. Reitemeyer. (M)
Louis A. Witte.

Plainfield

W. R. Causebrook. (A)
Thomas L. Melick. (D)

Princeton

John F. Hoff. (D)

Ridgewood

George S. Soult.

Sommerville

A. P. Beardsley. (C)

Summit

J. W. Hornsey. (C)
M. S. Sherwood.

Toms River

B. H. Spangenberg. (D)

Trenton

Charles G. Cook.
James H. Galt. (M)
Frank D. Moses.

West Hoboken

W. Greacen, Jr.

NEW YORK

Albany

F. S. Dunn. (M)
Wm. G. Furlong.
John J. Garrison.
E. P. Gavit. (A)
C. H. Graf. (M)
Frederick J. Ikena. (M)
C. F. Leonard.
Donald McDonald.
F. McDonald. (M)
William McDonald.
R. E. Sard.
F. A. Schobel.

Amsterdam

G. D. Conlee. (I)
W. H. Cooper. (M)

NEW YORK—*Continued*

Astoria, L. I.

F. J. Cotton. (M)
W. J. Hawthorne.
H. H. Himsworth. (M)
H. L. Jochum.
W. F. Lawrence. (M)
M. E. Mueller. (M)
John C. Shaw. (M)
N. J. Sperling. (M)
Crist H. Stevick. (M)
A. H. Zane.

Binghamton

Charles W. Bennett. (D)

Brooklyn

T. M. Ambler. (I)
F. R. Baldwin.
Fred. S. Benson, Jr. (M)
Charles Boone.
John H. Braine. (M)
Robert W. Bush. (M)
Edward J. Byrne.
Edward Louis Byrne.
Thomas E. Byrne.
George S. Callaway. (M)
C. E. Cheeseman. (M)
W. VanAlan Clark. (M)
J. H. Cozzens. (D)
Charles A. Cross. (M)
Guy K. Dustin.
Charles M. Ford.
Raymond L. Greene. (M)
G. S. Hendrickson. (M)
A. B. Hohmann. (M)
W. A. Jack. (M)
Edwin D. Jones.
E. R. Jourdan.
James H. Jourdan. (M)
R. C. Kellogg. (D)
Thos. P. Kennedy.
W. W. Kunze. (M)
J. P. Leask. (M)
John D. Logan.
Henry E. McGowan.
R. MacSaveny, Jr.
E. H. Mathews. (M)
Samuel A. Mills. (M)
Albert F. Murphy.
E. J. Murphy. (C)
H. B. Reading. (M)
A. H. Schaaf. (M)
J. Fred Seamon.
Samuel V. Seddon. (M)
S. W. Slater. (D)
A. F. Staniford.
L. S. Stiles. (M)
R. H. Strader. (M)
Andrew J. Voorhees. (M)
W. M. Wepfer. (M)
John T. White. (D)
Prescott B. Wiske.
Edward C. Uhlig. (C)
H. A. Wuest.

Buffalo

Lucius S. Bigelow. (D)
J. E. Burke. (D)
H. C. Palmer. (M)
William S. Riselay. (A, D, I)

Canandaigua

V. A. Miller.

Coney Island

Harry J. Dillon.
Geo. Herbert Woodall.

Far Rockaway

Edw. L. Davies.
L. A. Howland.
Carlton Macy. (M)
Edward H. Marsh. (D)
J. C. Sheehy.

Flushing

M. H. Spear. (M)
Edw. J. Sullivan.
W. H. Sullivan.

Geneva

E. H. Palmer.

NEW YORK—*Continued*

Glens Falls

H. M. Collin.

Gloversville

Louis C. Smith.

Hempstead

C. F. Callahan.
O. J. A Lundblad. (M)
W. W. Nissley. (D)

Ithaca

James W. Murdock. (M)

Kingston

R. F. Chidsey.
C. R. Stull.
Franklin Tobey, Jr.

Long Island City

Clifford S. Fox.
O. H. Smith. (M)
Harry L. Snyder. (A)
C. G. M. Thomas. (A)

Middletown

C. H. Stone. (I)

Mt. Vernon

G. E. Bennitt.
Chas. F. Bryant. (A)
William J. Clark.
Sidney S. Coles.
Edgar B. Davis.
J. W. Green.
Robert J. Jennings.
Alfred M. Keene. (A)
R. M. Kellogg. (M)
George T. Macbeth. (D)
W. L. Secord. (D)
Stanley G. Tarrant. (A)
Stuart Wilder.

Newburgh

A. R. Beal. (I)
G. H. Smith. (D)
F. W. Vredenburgh.

New York City

H. C. Abell.
Walter R. Addicks.
A. B. Allen. (M)
H. E. Almberg.
H. W. Alrich. (M)
J. Charles Andrews.
J. H. N. Armstrong. (A)
C. G. Atwater. (C)
C. T. Ayres.
A. C. M. Azoy.
T. S. Barlow. (M)
W. W. Barnes. (I)
F. H. Barnitz. (A, D, I)
William E. Barrett.
Wm. F. Barrett. (M)
W. H. Barthold.
Eugen Becher.
F. Behrend.
E. W. Bell.
W. C. Besson. (D)
William H. Bradley.
James C. Brady.
Ernest C. Brown.
H. M. Brundage. (A)
Martin F. Buckley.
J. H. Budde. (M)
D. M. Bull.
Sterling H. Bunnell. (M)
Thos. J. Byrne. (M)
Elbert P. Callender.
S. K. Campbell. (D)
C. M. Carbonell. (D)
Frank Carpenter.
Harold Carpenter.
Robert A. Carter.
Robert A. Carter, Jr. (M)
Dr. Chas. F. Chandler.
C. H. B. Chapin.
E. S. Chapin.
Frank P. Cheesman.
S. R. Church. (C)

NEW YORK—*Continued*

New York City

B. C. Cobb.
W. W. Cole.
Francis Colton.
James P. Conroy. (I)
Horace G. Cooke. (M)
Marshall Cornine.
George B. Cortelyou.
William M. Crane. (M)
Philip Cross.
H. R. Crowell.
J. L. de Castro. (M)
William DeFreitas.
F. R. DeVoe.
J. Alfred Dixon.
R. M. Dixon.
George W. Doane.
Henry L. Doherty.
Chas. Dougherty. (D)
F. J. Down. (M)
Philip Dunne. (D)
W. K. Eavenson.
A. B. Eilbeck.
Arthur H. Elliott. (C)
Charles B. Elmer.
J. R. Fenniman. (A)
Wm. M. Flook.
Henry Floy.
James R. Floyd.
O. H. Fogg.
Alfred E. Forstall. (M)
Charles G. Francklyn. (M)
Gilbert Francklyn.
Frank W. Frueauff.
Lewis B. Gawtry.
C. J. Gefvert.
Patrick Goodman.
W. R. Goudy. (A)
Malcolm M. Graham.
Orange G. Griffin. (D)
C. A. A. Griffiths.
Norman J. Griffiths. (A)
R. G. Griswold.
F. E. Haag. (A)
Theodore Haight. (C, M)
A. H. Hall. (D)
J. M. Haralson.
Joseph B. Hare. (D)
W. K. Harrington.
W. P. Hayes.
Harold A. Hayward. (D)
Sterling F. Hayward.
Frederick D. Herbert.
C. M. Higgins.
Willard F. Hine. (A)
Chas. H. Hodges. (M)
Frederic deP. Hone. (M)
David L. Hough.
Abram C. Howard.
W. G. Hoyt.
D. S. Hudson. (M)
A. C. Humphreys. (A)
F. W. Humphreys. (D, M)
Jas. F. Hunter. (M)
Edward B. Hyde. (A, D, I)
H. B. Hyland.
Charles W. Isbell.
C. N. Jelliffe. (D)
Adolph C. Johnson.
Mervyn E. Johnston. (A)
C. F. Keegan. (M)
Wm. D. Kelley.
James S. Kennedy. (M)
A. G. King.
I. Clayton Kingsbury
M. Kirchberger. (I)
Paul Kruger.
George Lange. (A)
Alanson P. Lathrop.
Albert Lauber. (I)
James Lawrence. (A)
Robert E. Livingston
Edward G. Love.
Charles E. Lucke.
Robert O. Luqueer. (M)
Joseph Lush.

NEW YORK—*Continued*

New York City

E. A. Lyon.
J. W. McClellan. (M)
William McClellan. (M)
Isaac McGraw. (M)
Wm. J. McGurty.
W. N. McIlravy.
H. B. McLean.
Emerson McMillin.
Marion McMillin.
Norman Macbeth.
George MacDonald.
W. L. MacIntosh. (M)
A. Fred Macklin. (M)
D. T. MacLeod.
J. H. Mansfield.
F. C. Martineau. (D)
John A. Mason.
J. Alex. Mayers.
Giles W. Mead.
Preston S. Millar. (I)
Alten S. Miller. (M)
Robert C. Miller.
L. B. Moorhouse.
Clarence P. Morrell.
W. Cullen Morris. (M)
William G. Morris. (A)
G. P. Morrow.
E. A. Nelson. (D)
John F. Nelson.
F. H. Nickerson.
Edwin North.
John O'Connell. (M)
M. Webb Offutt. (M)
Alva L. Palmer. (D)
Harry M. Papworth.
G. W. Parkhurst. (A)
A. Parshall.
H. L. Peden.
Irwin W. Peffly.
J. H. Perkins. (A)
C. Pilz.
Daniel J. Prendergast. (I)
Charles Raabe. (M)
George G. Ramsdell.
William W. Randolph.
Wm. T. Rasch. (D)
P. F. Reichhelm.
Hugo B. Reinach. (A)
James F. Reynolds.
Wm. H. Rhoads.
Daniel Riordan.
Arthur R. Ritchie. (M)
Chas. D. Robison. (M)
Wm. A. Root.
Robert R. Rust.
Eugene Y. Sayer. (M)
E. H. Schmidt. (D)
Philip J. Schneider. (A)
Thomas Scofield. (I)
Thomas Shaughnessy, Jr.
Richard Shepard.
Marvin Shiebler.
C. C. Simpson. (D)
Henry Simpson.
Alex. Sinai.
C. G. Smith. (A)
Elliott L. Spencer.
R. E. Sperry.
Arthur W. Stark. (M)
C. N. Stevens. (C)
John Stilwell.
F. M. Tait.
G. W. LeR. Travis. (D)
Lucien P. F. Tull. (A)
Alfred E. Turner. (D)
H. L. Underhill. (M)
W. H. Van Winkle. (D)
George H. Warner.
Albert J. Weber.
F. C. Weber. (M)
T. G. Weber. (M)
Louis H. Werner. (A)
M. C. Whitaker. (C)
Benjamin Whiteley.
Louis Wilputte.
G. J. Wilson.

NEW YORK—*Continued*

New York City

R. M. Wilson. (D)
S. E. Wolff. (D)
George E. Woods.
Edwin S. Young. (D)

Niagara Falls

Albert H. Merritt.

Nyack

E. C. Peebles. (M)

Olean

A. L. Benton. (M)

Ossining

O. G. Bennett. (A)
H. W. Terry, Jr. (D)

Oswego

R. F. Whitney. (M)

Owego

A. P. Storrs. (I)
Chas. P. Storrs. (I)

Penn Yan

Wm. T. Morris.

Plattsburg

George M. Cole.

Portchester

J. K. Crowell. (D)
Joseph P. Kane. (D)

Port Washington

John E. Bullard. (I)

Poughkeepsie

T. R. Beal. (D, M)
Hugh M. Beugler. (D)
L. H. Scherck. (I)
Charles Waldron, Jr. (M)
A. R. Wellwood.

Rochester

J. C. Collins.
James B. Eaton.
Joseph P. Haftenkamp. (M)
Frank Hellen.
James T. Hutchings.
I. Lundgaard. (M)
Joseph P. MacSweeney.
Herman Russell.
Karl A. Schick.
E. C. Scobell. (A)
Robert M. Searle. (M)
C. A. Tucker. (A)

Rome

H. W. Mitchell.
A. B. Morton. (M)

Saranac Lake

Charles A. Gruber. (D)

Saratoga Springs

Patrick F. Roohan. (M)

Schenectady

Henry W. Peck. (A)
V. vonStarzenski. (M)
M. G. Welsh. (M)

Stapleton

John J. Callahan. (D)
W. M. R. Hammond. (A)
H. Mueller, Jr. (D)
William J. Welsh. (M)

Syracuse

William H. Blauvelt. (M)
C. M. Cole
James C. DeLong. (I)
S. J. Dickey. (M)
Arthur D. Dudley.
E. W. Poole. (A)
Bates Torrey, Jr.
W. D. Scott. (D)
S. C. Singer. (D)
W. N. Tolman. (M)
L. M. Whitwell. (M)
Edwin C. Witherby. (M)

Tarrytown

Ernest R. Conover. (A)
H. B. Kellogg.
John A. Neth.

Troy

James H. Caldwell.
W. C. Coleman.
Henry C. Shields. (M)

NEW YORK—*Continued*

Utica

William J. Cahill. (D)
H. G. Johnson. (M)

Watertown

Fred A. Rogers. (A)
John B. Taylor.
Peter Young.

Westchester

John D. Alden.
J. M. Butler.
Eugene H. Rosenquest.

West Point

I. N. Goff, Jr.

White Plains

John Malakoff.
E. S. Martin.
Martin Morrison.

Yonkers

E. O. Baxter.
J. E. Galligan.
A. M. Knapp.
Herbert Sherwood. (D)
Charles F. Timm.
Wm. G. Wright.

NORTH CAROLINA

Asheville

J. D. Caldwell. (M)
H. W. Plummer.

Greensboro

Charles H. Andrews.

New Bern

F. H. Sawyer.

Raleigh

S. P. Cobb. (M)

Rocky Mount

J. B. Cocke. (M)

Winston-Salem

B. N. Sullivan.

OHIO

Alliance

D. W. Low.

Ashtabula

Frederick W. Stone.

Bucyrus

H. O. Dutter.

Chillicothe

F. A. Stacey.

Cincinnati

William A. Miller.
Andrew J. Stacey.
James E. Stacey.

Cleveland

D. K. Crighton.
C. S. Eaton.
H. C. Fritz.
C. C. Gartland.
F. R. Hutchinson. (D)
Edward P. Hyde. (I)
William H. Knight. (M)
Melvin Pattison. (M)
A. T. Perry. (C)
C. H. Printz.
W. E. Steinwedell.
Frank E. Taplin.
D. R. Warmington.
J. G. Way.

Columbus

Thomas J. Jones.
S. S. Wyer.

Dayton

Edward H. Light. (D)
George Light.
W. W. Price.

Delaware

Thomas Clive Jones.

Hamilton

Lazard Kahn.

Mansfield

William C. Hedges. (M)

Marion

George Whysall.

OHIO—*Continued*

Middletown

G. F. Ahlbrandt. (M)

Steubenville

E. H. Collester. (M)

Warren

George Daugherty.

Youngstown

Fred S. Coombs. (M)
Caleb Davies, Jr. (M)
W. E. Manning.
Karl Nibecker. (M)
G A. Reinhardt.

OKLAHOMA

McAlester

F. A. Willard.

Tulsa

E. E. Eysenbach.

OREGON

Portland

W. B. Foshay.
Elmon L. Hall. (C, D, M)
Hilmar M. Papst.

PENNSYLVANIA

Allentown

J. Ward Crankshaw.
John A. Frick.
A. C. Taylor. (M)

Ardmore

Howard Hoffman. (M)
Isaac N. Knapp. (M)
John L. Mather.

Berwick

L. D. Spragle. (M)

Bethlehem

W. F. Brodnax.
R. C. Graveley.
R. C. Morris, Jr.

Bolivar

N. A. Young. (M)

Bradford

George P. Boothe.
Fred A. Miller. (M)

Carbondale

Chas. L. Rowland.

Catasauqua

G. W. Steele.

Chester

Hugh C. Aiken.
L. D. Huestis. (M)
J. D. Shattuck.
George W. Thomson. (I)
Wm. M. White.
Charles Wilde. (D)

Clearfield

Warren Partridge. (D)

Coatesville

A. P. McCarthy.

Collingdale

Thomas B. Tinney.

Colmar

R. H. Dutton.

Darby

Charles J. Fox.

Easton

B. F. Cresson.
Edwin G. Holzer.
Wm. D. Ray.

Erie

F. H. Payne.

Hamburg

A. J. Althouse.

Harrisburg

C. M. Kaltwasser.
Luther S. Williams.

Irwin

Edwards F. Wilson.

Kennett Square

G. J. Maloney.

Lebanon

Geo. S. Speaker.

Leetsdale

H. A. Carpenter.

Lewistown

Frank P. Duggan.

PENNSYLVANIA—*Continued*

McKeesport

C. E. Underwood.

Norristown

H. B. Bryans. (M)
H. H. Ganser. (I)

Oakmont

F. W. Speer, Jr. (C)

Philadelphia

H. C. Adams.
E. R. Alburger. (M)
Walter A. Allison. (M)
Howard B. Andersen. (D)
James Ball.
Henry S. Battin. (D)
Wm. P. Baylie. (A)
Albert B. Beadle. (M)
R. H. Beaumont. (M)
Walter W. Beaumont.
Samuel Taylor Bodine. (D)
Charles O. Bond. (I)
Cyrus Borgner. (M)
Albert M. Boyd. (D)
C. A. Braun.
Wm. L. Brown.
Charles L. Bruff. (M)
Joseph Butler.
Ervin Calhoun. (A)
F. A. Canon.
E. G. Carlisle.
Henry R. Cartwright. (M)
Andrew J. Carty.
William A. Castor. (D)
Walter L. Chewning.
W. A. Clader. (A)
Charles J. Clark.
Walton Clark.
David J. Collins.
E. M. Colquhoun.
H. R. Cook, Jr. (M)
R. C. Cornish.
J. A. P. Crisfield.
W. T. Crouse. (A)
G. W. Curran. (A)

Samuel P. Curtis.
R. E. Dallas. (A)
P. T. Dashiell. (M)
H. W. Davies. (M)
William F. Dorner. (M)
James B. Douglas. (D, M)
W. F. Douthirt.
Ronald B. Duncan. (D)
W. G. Earnshaw.
L. B. Eichengreen. (M)
Owen B. Evans. (M)
S. E. Fairchild, Jr. (M)
Walton Forstall. (D)
J. Scott Fowler. (D)
F. C. Freeman.
W. H. Fulweiler.
J. W. Galloway.
W. H. Gartley.
Clarence H. Geist.
Thomas S. Genay.. (A)
Francis H. Gilpin. (I)
H. W. Graeff.
Albert W. Grant, Jr. (M)
Albert Green.
John Gribbel.
W. Griffin Gribbel. (D)
Rowland E. Griffis. (D)
H. O. Gross.
Clifford L. Haldeman.
Charles F. Hardick. (A)
C. Willing Hare.
Geo. M. Harrison.
William E. Helme. (D)
G. R. Hemminger. (A)
J. H. Hubbs.
Herbert E. Ives.
Thos. H. Jackson. (A)
Robert C. James.
C. C. Jones.
Edwin P. Jones.
William Kane.
R. L. Klar.
August C. Klein. (M)
J. B. Klumpp. (M)
D. S. Knauss. (M)

PENNSYLVANIA—*Continued*

Philadelphia

P. J. Lafore.
W. P. Lane.
Louis R. Lemoine.
Lewis Lillie.
H. Livingston.
John McIlhenny.
John D. McIlhenny.
Andrew P. Maloney. (M)
William H. Marshall. (A)
P. C. Mayfield. (M)
James B. Mingus.
F. N. Morton. (M)
Wayne R. Moyer.
H. P. Murphy. (M)
Edw. B. Myers.
Joseph B. Myers.
H. H. Nevanas. (M)
Carroll B. Nichols.
Rollin Norris.
C. J. O'Donnell.
William H. Parish.
Joseph Smith Parker.
J. A. Pearson.
Harry G. Peck.
H. P. Penfield. (M)
M. F. Perkins. (M)
Rowan P. Perkins. (M)
Jos. A. Perry. (M)
H. W. Plucker.
Edward Porter. (A)
John V. Postles.
Clarence V. Roberts. (D)
Chauncey D. Robinson.
Edward H. Rodgers.
Robert J. Rolston.
William L. Rowland. (C)
John M. Ruegenberg.
John M. Rusby. (M)
James Russell.
F. J. Rutledge.
W. F. H. Schultz. (M)
H. S. Schutt.
Harold K. Seeley. (D)
William J. Serrill. (D)
A. E. Shaw.
Howard R. Sheppard.
J. H. Smith. (A)
Charles S. Snyder. (D)
Jacob W. Stirzel.
L. J. Strause.
Morris W. Stroud.
Walter Sturdevant.
W. B. Taber, Jr. (M)
J. Hawley Taussig. (M)
P. D. Taylor. (M)
Nathaniel W. Thomas. (C)
Paul Thompson.
Fred G. Thorn, Jr.
C. C. Tutwiler. (C)
E. P. Walter. (D)
Chas. P. Warner. (D)
J. H. Warnick.
John S. Welch.
D. B. Wentz. (M)
F. V. Westermaier. (I)
Henry Wharton.
Walter Whetstone.
Robert H. Whipple.
Edward R. Wood, Jr. (M)
Wm. M. Wood. (D)

Pittsburgh

Arthur Booth.
Alfred P. Brill.
Albert G. Davis. (C)
Charles D. Evans.
Otto F. Felix. (M)
R. C. Frampton.
J. E. Gill.
Joseph F. Guffey.
William H. Hammon.
Henry Koppers.
Edw. D. Leland.
T. L. Lewis.
Walter L. McCloy.
J. C. McDowell.
Wm. McKee. (M)
C. S. Mitchell. (A)
John J. Murray.

PENNSYLVANIA—*Continued*

Pittsburgh

G. R. Nutty.
C. J. Ramsburg. (M)
James H. Reed, Jr.
Joseph A. Reed.
Edwin Ruud.
T. V. Salt.
W. F. Schell. (D)
Kenneth Seaver.
Thomas J. Smith, Jr.
Frank N. Speller.
Samuel B. Stewart.
E. C. Weisgerber. (D)
Wm. W. Weller.
Robert W. H. Young.
R. H. Youngman.

Reading

George B. Bains, 3d.
John H. Keppelman.

Scranton

Worthington Scranton.
Harold N. Squier. (M)
E. M. Stack. (A, D, I)

Smethport

Melville Gillett

Sunbury

George W. Beck. (D)

West Chester

William O. Lamson, Jr.

Williamsport

Ernest H. Davis.
Wm. R. Rhoades.

Wyncote

N. B. Bertolette. (C)
L. R. Dutton. (D)

RHODE ISLAND

Newport

A. K. Quinn.

Pawtucket

William McGregor. (M)
John E. Morgan.
E. I. Patt.

Providence

George E. Allyn.
G. S. Barrows. (D)
Edmund Cathels. (M)
John W. Ellis.
H. H. Field. (M)
T. H. Hintze. (M)
Roger W. Polk. (M)
W. H. Price. (M)
C. G. Richardson.
R. E. Slade. (M)

Slocums

A. B. Slater. (M)

Woonsocket

F. J. Nason. (D)
Alfred F. Townsend. (D)

SOUTH CAROLINA

Charleston

C. M. Benedict.
J. G. Felton.
P. H. Gadsden.
Edward C. Kollock. (M)
G. H. Waring. (M)

Columbia

S. W. Brown.

Spartanburg

J. A. Callenbach.

SOUTH DAKOTA

Aberdeen

Charles A. Howard.

Mitchell

E. J. Sherwood. (D)

Sioux Falls

A. S. Graham

TENNESSEE

Chattanooga

S. E. DeFrese. (D)

TENNESSEE—*Continued*

Knoxville

Alfred W. Young.

Memphis

L. G. Van Ness.

Nashville

Roger B. Combs. (M)
S. E. Linton, Jr.
G. Maxwell Johnson.
B. V. Pfeiffer. (M)

TEXAS

Abilene

G. H. Caffrey. (M)
A. V. Wainwright. (D)

Beaumont

M. T. Walker.

Dallas

Henry C. Morris.

El Paso

Keating L. Simons. (M)

San Antonio

E. B. Henson.
W. B. Tuttle. (M)

UTAH

Salt Lake City

John C. D. Clark. (M)
H. C. Estberg. (C)
Wm. R. Putnam. (I)

VERMONT

Burlington

David W. Jardine.
Frank H. Parker.

VIRGINIA

Big Stone Gap

Otis Mouser. (M)

Charlottesville

H. M. Hantzmon.

Danville

Frank Talbott. (D)

Lynchburg

L. G. Gresham.
Albert J. Kohler.
Ward Wilson.

Newport News

W. F. Croston. (M)

Norfolk

E. C. Hathaway.
R. J. Marks.

Petersburg

R. A. Goudy.

Portsmouth

B. B. Ferguson.

Richmond

William P. Knowles.
W. H. Matlack, Jr. (M)
G. E. Tozier.

Roanoke

M. M. Milton.

Suffolk

Chas. H. Brown.
J. Edw. Francis.
A. E. Lockwood.

WASHINGTON

Aberdeen

P. A. Bertrand.
N. S. Burcombe. (M)

North Yakima

W. A. Bertke.

Seattle

Edward A. Dieterle.
N. C. Fancher.
Frederick K. Lane.
A. F. Mueller.

Tacoma

W. A. Leuenberger. (M)
William W. Seymour. (C)

Wenatchee

Arthur Gunn.

WISCONSIN

Beloit

Philip S. Dickey. (D)
Robert G. Krumrey. (D)
B. F. Lyons. (M)

Janesville

I. F. Wortendyke.

Madison

John Corscot.
F. L. Cross. (A)
Wiley J. Huddle.
O. L. Kowalke. (C)
John St. John.

Milwaukee

John F. Blackie. (M)
R. B. Brown. (M)
Sheldon J. Glass.
Ewald Haase. (A)
Henry M. Humphrys. (M)
R. P. Kraft.
C. E. Lewars.
G. W. Mackie.
John T. Mason.
David A. Powell.
Bruno Rahn. (M)
H. L. Rice. (A)
Ferdinand Schlesinger.
John W. Shaeffer. (M)
A. C. Wilke. (C)
John C. Wilson. (D)

Oshkosh

Sinclair Mainland.
William Mainland.

Watertown

C. A. Comstock.

Wausau

H. H. Wilson. (M)

CANADA

Brandon, Manitoba

M. L. Kane.

Calgary

A. I. Payne. (M)

Chatham

P. S. Coate. (D)

Hamilton

John Keillor. (M)
John B. McNary.

Montreal

J. S. Haug.
Howard E. Mann. (M)
W. F. Pearce.

Quebec

R. A. Wallace.

Toronto

Frederick Burnett.
Arthur Hewitt.
Daniel L. Hill.
W. H. Pearson.

CUBA

Havana

Americo R. Gonzalez.
W. E. Mockett.

ENGLAND

Grays, Essex

Arthur W. Sumner.

London

F. J. Angell.
Wm. A. Bone.
L. D. Carroll.
Arthur G. Glasgow. (M)
A. O. Jones.
Frederic Thuman.
John Townsend Westcott.
T. A. Vander Willigen.
Corbet Woodall.

Liverpool

William King.

Nuneaton

George Helps.

HAWAII

Honolulu

Harry L. Strange. (M)

JAPAN

Ichigi, Mikawa

Hideichi Kawai.

JAPAN—*Continued*

Kobe

Shosuke Kubo.

Nagoya

Sakura Okamoto.

Osaka

Chas. P. Cushman.
Kotaro Shimomura. (M)

NETHERLANDS

Rotterdam

M. C. Sissingh.

NEW ZEALAND

Christchurch

R. C. Bishop. (D)

PHILIPPINE ISLANDS

Manila

Erich Odrich.

PORTO RICO

Ponce

Francis Colton.

Rio Piedras

F. S. Pugh. (D)
W. A. Tobias.

SWITZERLAND

Minusio

A. E. Boardman. (M)

SUMMARY—GEOGRAPHICAL.

Alabama	7
Arkansas	1
California	51
Colorado	5
Connecticut	32
Delaware	1
District of Columbia	10
Florida	11
Georgia	14
Illinois	117
Indiana	38
Iowa	31
Kansas	5
Kentucky	8
Louisiana	4
Maine	10
Maryland	20
Massachusetts	80
Michigan	68
Minnesota	18
Mississippi	2
Missouri	38
Montana	3
Nebraska	9
New Hampshire	5
New Jersey	99
New York	409
North Carolina	7
Ohio	38
Oklahoma	2
Oregon	3
Pennsylvania	236
Rhode Island	17
South Carolina	7
South Dakota	3
Tennessee	7
Texas	7
Utah	3
Vermont	2
Virginia	18
Washington	10
Wisconsin	29
Canada	13
Cuba	2
England	12
Hawaii Territory	1
Japan	5
Netherlands	1
New Zealand	1
Philippine Islands	1
Porto Rico	3
Switzerland	1
Total	1,525